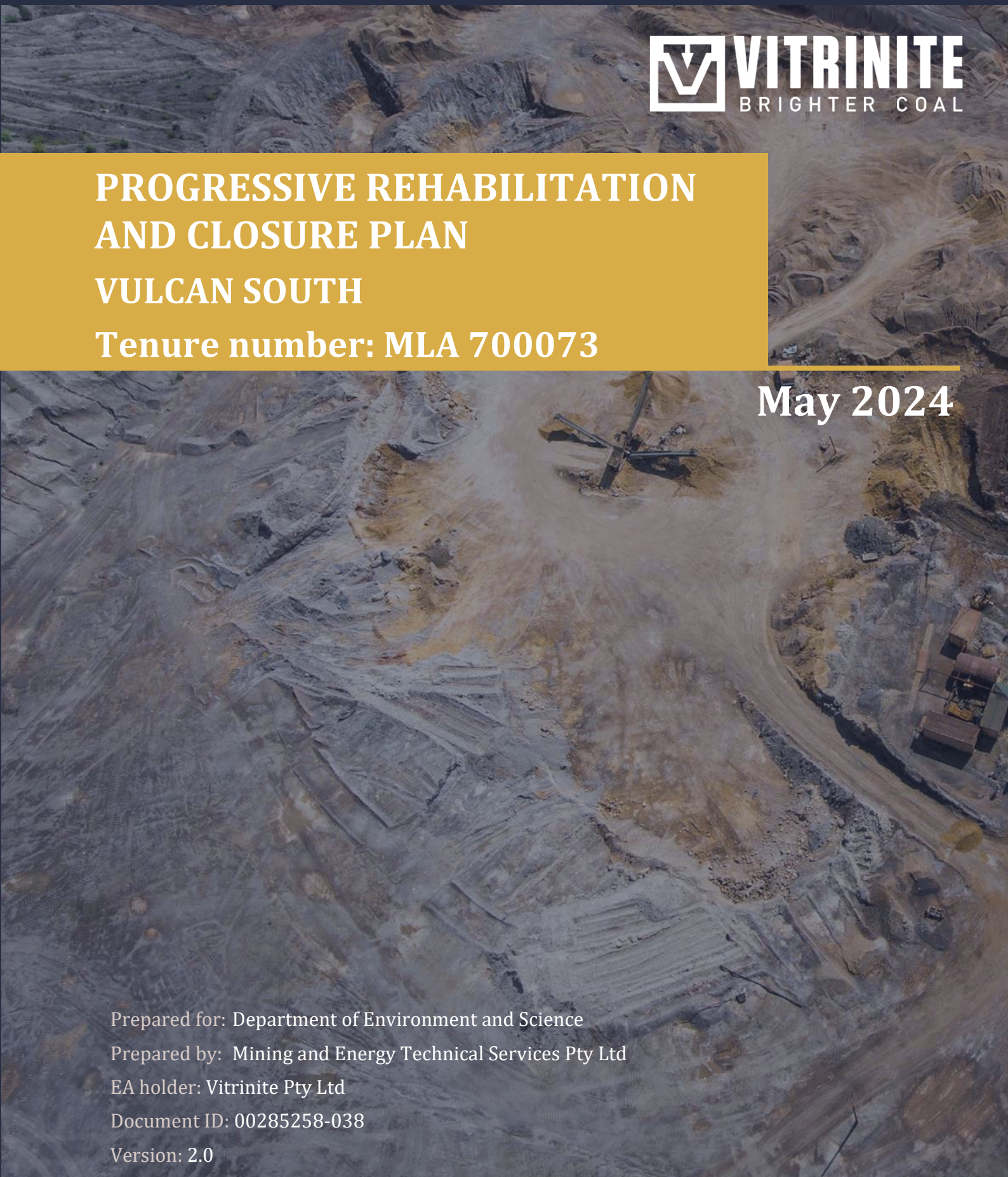

PROGRESSIVE REHABILITATION AND CLOSURE PLAN

VULCAN SOUTH

Tenure number: MLA 700073

May 2024

Prepared for: Department of Environment and Science

Prepared by: Mining and Energy Technical Services Pty Ltd

EA holder: Vitrinite Pty Ltd

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1 INTRODUCTION

Vulcan South (the Project) is a new small-scale coal-mining operation proposed by Vitrinite Pty Ltd, owner of Qld Coal Aust No.1 Pty Ltd and Queensland Coking Coal Pty Ltd (Vitrinite). This Progressive Rehabilitation and Closure Plan (PRC Plan) is to accompany a site-specific application for an environmental authority (EA) to undertake the project. This PRC Plan has been developed to meet the requirements specified in the Queensland Government's *Progressive Rehabilitation and Closure Plans Guideline* and Sections 126C and 126D of the *Environmental Protection Act 1994.*

This PRC Plan comprises two main components. The rehabilitation planning component (**Sections 1** to **9**) provides information on the characteristics of the site, legislative requirements, stakeholders, post-mining land use, rehabilitation goals, schedule of land availability, rehabilitation methodology, risk assessment and monitoring program. The PRC Plan schedule component (**Section 10**) provides a detailed schedule of works, including a final site design and rehabilitation milestones.

This PRC Plan provides a strategy for Vitrinite to manage their mining lease in a way that maximises the progressive rehabilitation of the land to a stable condition, as well as specifying the condition to which Vitrinite must rehabilitate the land before the EA may be surrendered.

1.1 Project Location

The Project is located north of Dysart and approximately 45 km south of Moranbah in Queensland's Bowen Basin (**Figure 1-1**). The Project lies to the immediate west of several established mining operations, including BHP's Peak Downs and Saraji mines, and south of Vitrinite's Vulcan Coal Mine.

1.2 Site Description

1.2.1 Resource Tenures

The Project's mining lease application (MLA) covers an area of approximately 3800 ha and is situated over multiple underlying resource tenures:

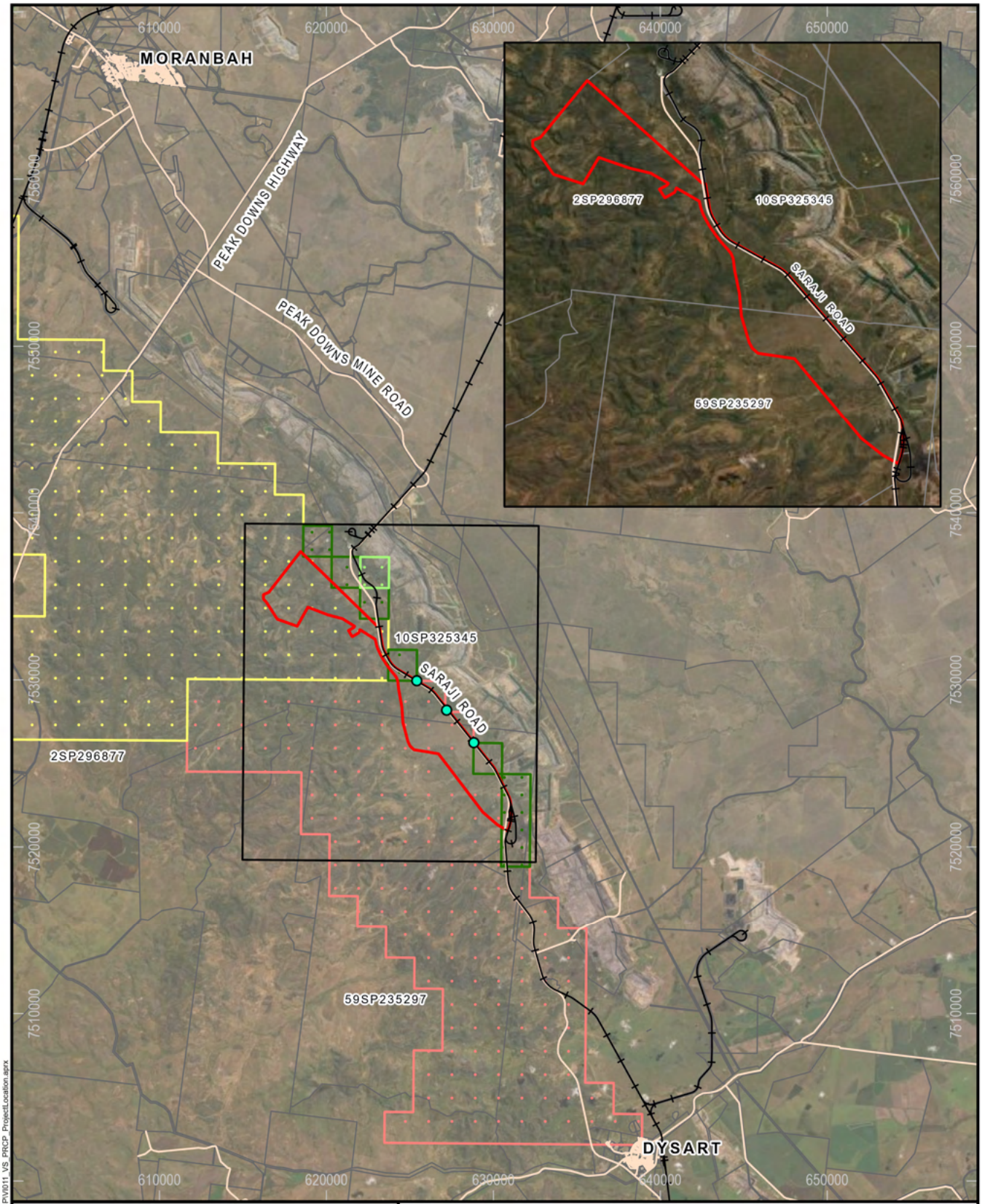
- Exploration Permits Coal (EPC):
  - 1732;
  - 1233; and
  - 1234.
- Parcel Prospecting Permits (PPP):
  - Vulcan South Area 1 and Area 2- Lot 26 on CNS125;
  - Vulcan South Area 2 and Area 3- Saraji Road (Road Reserve);
  - Vulcan South Area 2- Lot 2 on SP296877; and
  - Vulcan South Area 3- Lot 2 on CNS109.

These EPCs and PPPs are held by companies owned by Vitrinite and are shown in **Figure 1-1.**

The existing underlying properties, non-resource tenures, usage and owners/managers within the proposed ML boundary are discussed in **Section 1.2.11**.

1.2.2 Topography

The Project lies on plains and footslopes along the eastern edge of the Harrow Range. The Harrow Range (immediately west of Vulcan South) is generally 100-170 m higher than the surrounding plain. The plain itself slopes gently towards the east and varies in elevation from 210 metres Australian Height Datum (mAHD) in the south to 350 mAHD in the north (**Figure 1-2**).



Legend

- Prospecting Permits
- Railway
- Road
- MLA Boundary
- Cadastral Boundary
- EPC 1233
- EPC 1234
- EPC 1732
- Historical EPC 1732

Source: State of Queensland (Department of Resources) 2021-2022, Vitrinite 2022, METServe 2022, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\VI011_VS_PRCP_ProjectLocation.aprx

Vulcan South

Location Map Showing Resource Tenures of Vulcan South

0 3 6 12

Kilometers

Scale: 1:330,000 (A4)

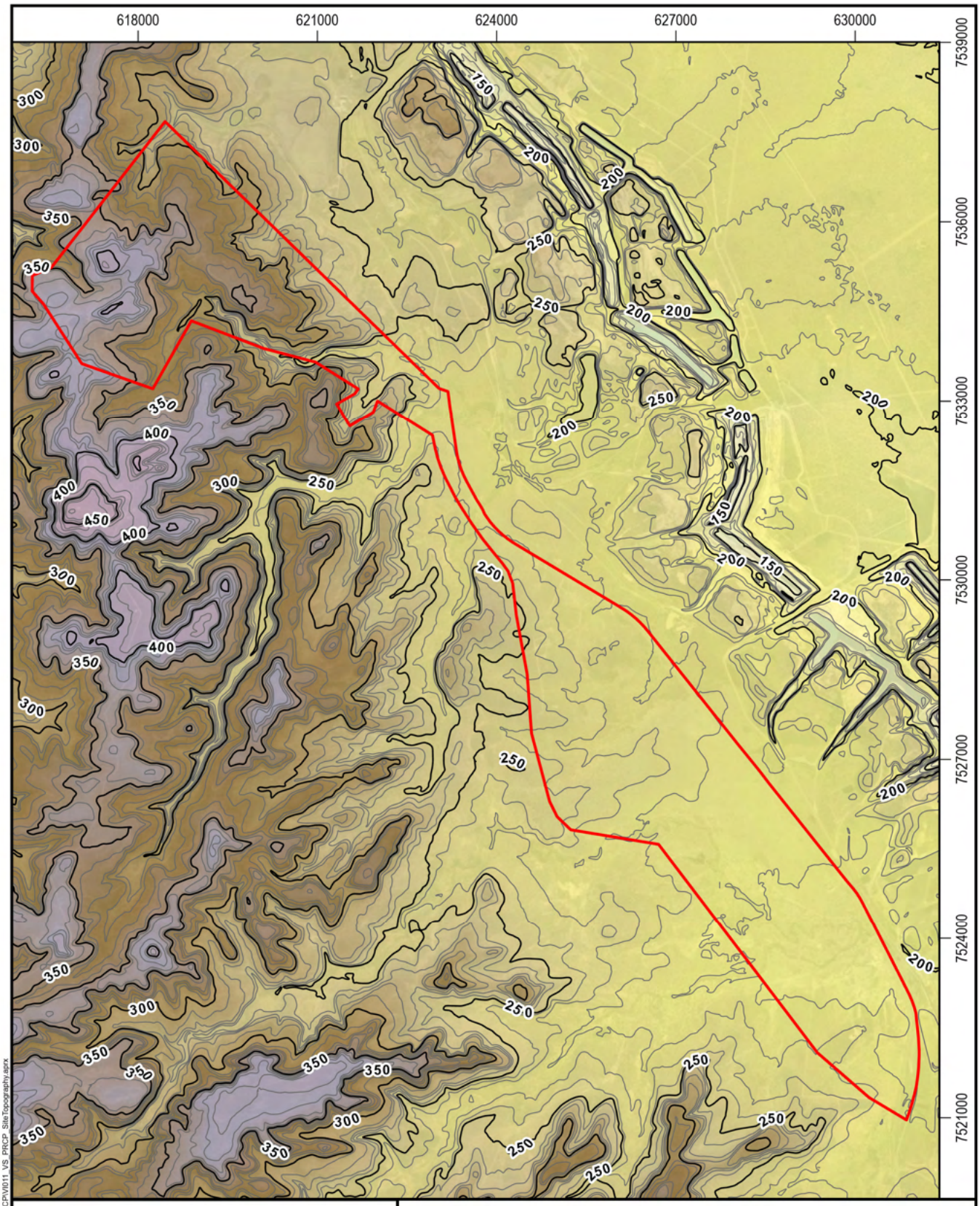
13/05/2022

Datum: GDA2020
Projection: MGA55

FIGURE 1-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

MLA Boundary

Contours

10m

50m

Elevation (m)

481.988

87.4393

Source: State of Queensland (Department of Resources) 2019, Vitrinite 2022, METServe 2022, Earthstar Geographics.

Path: S:\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\VI011_VS_PRCP_SiteTopography.aprx

Vulcan South

Site Topography

0 1.5 3

Kilometers

Scale: 1:92,000 (A4)

14/03/2022

Datum: GDA2020
Projection: MGA55

FIGURE 1-2

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

1.2.3 Climate

The Project area (defined by the MLA boundary) is subtropical, with hot summers and mild winters. The nearest Bureau of Meteorology (BoM) weather stations are Mount Lebanon (29 km northwest) and Seloh Nolem (29 km east), both of which are currently closed. The nearest active weather station is Moranbah Airport (35 km north-northwest), which only commenced operations in 2012. Given the inconsistency of locally available data for discerning long-term average weather patterns, the Queensland Department of Environment and Science's SILO database was used for estimating average rainfall on site. The SILO database uses mathematical interpolation techniques to fill temporal and spatial data gaps from BoM's weather stations. Based on data generated for the SILO grid point -22.35, 148.20, the mean and median annual rainfall for the Project is 590.6 mm and 575.1 mm, respectively. However, this varies widely between years: standard deviation = 204.2, range = 275.5 to 1,152.7 mm. On average, 70% of the annual rainfall occurs between November and March (**Figure 1-3**).

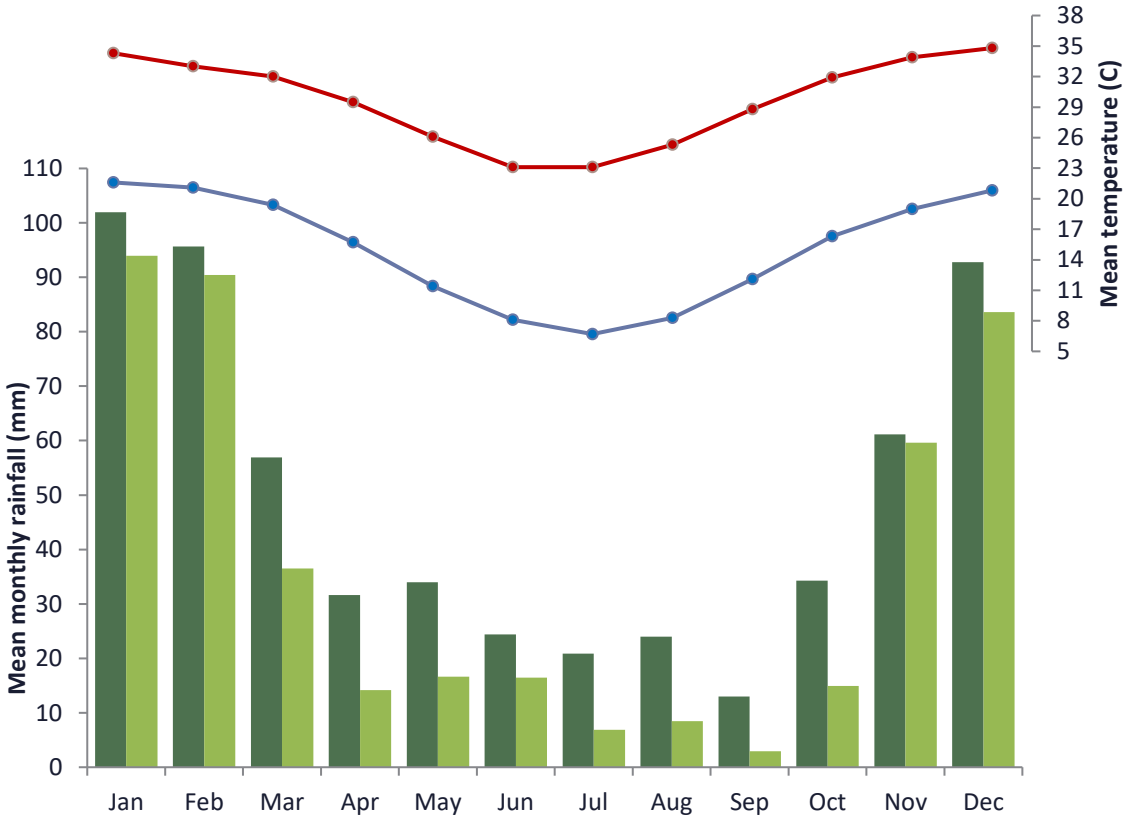


Figure 1-3 Average weather conditions at Vulcan South.
Green bars refer to the mean (dark) and median (light) monthly rainfall over the past 50 years, as interpolated in the SILO database (Bureau of Meteorology 2019) for the SILO grid point -22.35, 148.20. Mean monthly maximum (red) and minimum (blue) temperatures over the past 50 years come from the Clermont Post Office meteorological station.

The mean potential evaporation rate for every month exceeds the mean rainfall for the respective month. However, the size of this deficit varies with season. The period between September and December is historically the driest (**Table 1-1**), which has been considered when planning earthworks and planting programs as part of this PRC Plan.

Table 1-1 Mean potential evaporation rates and mean water deficits in the project vicinity throughout the year

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean rainfall (mm)	102	95.65	56.94	31.64	33.96	24.38	20.86	23.99	13	34.26	61.17	92.78
Mean evaporation (mm)	220.2	178.9	182.9	145.3	115.5	91.85	102.2	132.7	173.3	216	225.6	237
Mean water deficit (mm)	118.3	83.25	126	113.6	81.56	67.47	81.33	108.8	160.3	181.7	164.5	144.2

(from the SILO grid point -22.35, 148.20).

Climate change models produced by the CSIRO (2015) suggest with medium confidence that there will be long-term decreases in average winter and spring rainfall over the next 80 years. Long-term changes in summer and autumn rainfall are also possible, but the direction is unclear (CSIRO 2015). On the short timescales of the Project, the influence of natural rainfall variability is projected to predominate over trends due to increasing greenhouse gas emissions (CSIRO 2015), and the rainfall data presented in **Figure 1-3** is therefore most relevant to the Project during the rehabilitation and vegetation establishment stage. Over the next 80 years, however, an increase in the intensity of extreme rainfall events is projected with high confidence, and the time spent in drought is projected to increase with medium confidence. These long-term changes can affect the prospect of survival for long-lived trees.

The effect of climate change on temperature is projected to be more apparent short-term than for rainfall. For the near future (2030), the annually averaged warming across all emission scenarios is projected to be around 0.5 to 1.4 °C above the climate of 1986-2005 (CSIRO 2015); note that the current climate (as at the end of 2019) is already 0.24 °C warmer than the 1986-2005 average (CSIRO 2015). This warming is projected to be 1.3 to 5.0 °C by 2090 (CSIRO 2015). Temperature changes have been considered both for the vegetation establishment phase of rehabilitation and for the long-term survival of trees post-relinquishment. Species to be used in revegetation all have widespread geographic distributions (including hotter and drier locations than the Project area). It is therefore unlikely that the Project area currently represents the limit of environmental tolerance for any of the species utilised.

1.2.4 Geology

The geology of the Project area is influenced by its position within the Bowen Basin, one of Queensland's largest depositional zones, formed through a period of rifting and subsidence lasting from the Early Permian to the Mid-Triassic. The area surrounding the Project is dominated by clastic sedimentary rocks of marine and lacustrine origin, including sandstones, mudstones, siltstones and coal (Geoscience Australia 2019). Rock strengths range from extremely-low-strength weathered sandstone to high-strength fresh sandstone.

The solid geology of the region includes the:

- Moranbah Coal Measures - Permian, comprising coal and inter-seam material composed of sandstone, shale, siltstone with minor clay stone; and
- Back Creek Group - Early to Late Permian, comprising quartzose to lithic sandstone, conglomerate, siltstone, carbonaceous shale and coal. Occurs beneath the Moranbah Coal Measures, and outcrops to the west of the disturbance footprint.

The Permian and Triassic sediments are covered by a thin veneer of unconsolidated to semi-consolidated Cainozoic sediments (Tertiary to Quaternary alluvium and colluvium):

- Qr –(QLD) (Qr) – Quaternary clay, silt, sand, gravel and soil with colluvial and residual deposits; and
- TQa - QLD (TQa) - Late Tertiary to Quaternary poorly consolidated sand, silt, clay, minor gravel and high level alluvial deposits.

Across the Project area, the uppermost stratum is generally a highly weathered regolith comprising a heterogeneous distribution of fine- to coarse-grained sand, clay, sandstone and claystone. These are either Tertiary sediments or a weathering profile that had developed during the Tertiary on Permian strata.

The base of weathering typically extends to depths of 15 to 45 mbgl (metres below ground level), where the unweathered Moranbah Coal Measures commence. Near the Project area the cumulative thickness of coal appears to be between 5 m and 15 m. The intention is to mine the lower seams of the Moranbah Coal Measures (the ALEX and Dysart Lower-Lower (DLL) coal seams).

Outcropping to the west of the Project is the basal section of the Moranbah Coal Measures, a sequence of sandstones and siltstones, with imbedded coal. The ALEX coal seam lies near the top of this sequence, just below the base of weathering. It is of high quality and low ash content, and is about 1 m thick. It overlies resistant, quartzose, medium- to coarse-grained sandstone, locally referred to as the Mesa Sandstone due to the characteristic mesa plateaus that have formed in the region. At its base, the Mesa Sandstone grades into the Mesa Siltstone.

The DLL coal seam lies immediately below the Mesa Siltstone. It lies near the base of the Moranbah Coal Measures. The DLL consists of a 2.5-m-thick seam with four plies, and contains high-ash and good-quality coal. An additional and a separate 1-m-thick coal seam beneath the main seam makes the entire sequence to be mined approximately 3.5 m thick.

Beneath the Moranbah Coal Measures are the Exmoor and Blenheim formations of the Back Creek Group. The top of the Exmoor formation is characterised by prominent, coarse-grained, siliceous boulder sandstone in outcrop, whilst the top of the Blenheim Formation is characterised by fossiliferous and worm-burrowed sandstone.

No igneous intrusions have been encountered within the Project to date in either drilling or field mapping exercises. However, neighbouring mining operations (the north and far west of EPC1234 and EPC1729) have localised basalt dykes and potential sills within their leases.

A conceptual diagram of the main geological units is shown in **Figure 1-4**, and representative stratigraphy of the Project geology is shown in **Figure 1-5**.

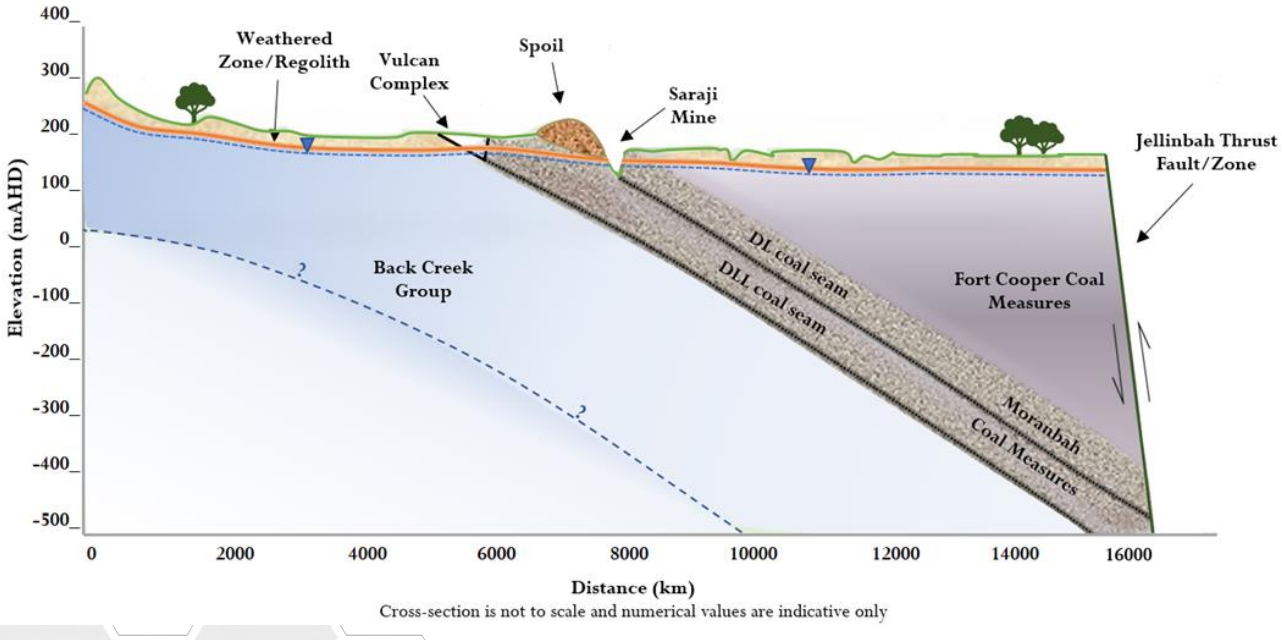


Figure 1-4 West-to-east conceptual geological model of the Project area

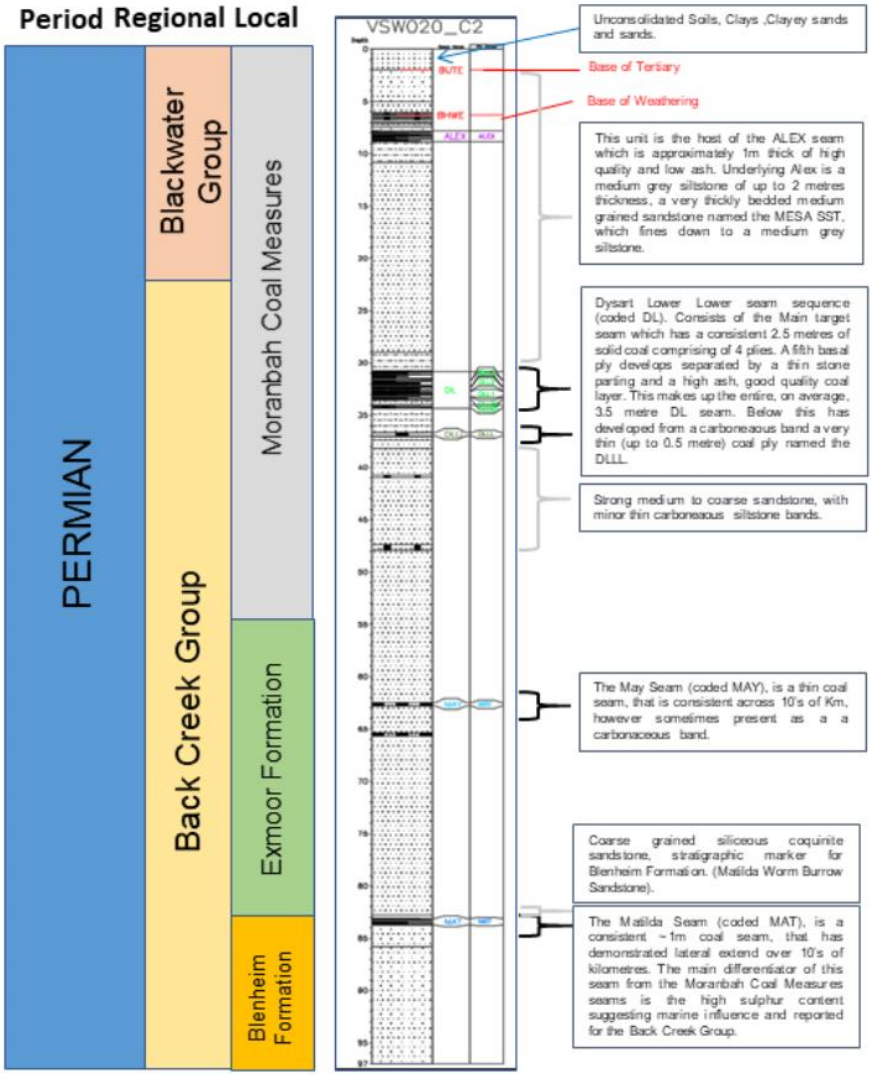


Figure 1-5 Representative stratigraphy of the Vulcan South area

1.2.5 Hydrology

A surface water assessment of Vulcan South has been carried out by WRM Water + Environment (WRM) (**Appendix A**). This is summarised below.

Vulcan South is located within the Isaac River sub-basin of the Fitzroy Basin. **Figure 1-6** depicts the Upper Isaac Catchment to its confluence with Phillips Creek and the proposed Vulcan South MLA.

The Isaac River commences 100 km to the north of Vulcan South in the Denham Range. It drains in a south westerly direction through the Carborough and Kerlong Ranges before turning in a south easterly direction near the Goonyella Riverside Mine. It drains 30 km to the east of Vulcan South, and eventually flows to the Mackenzie River 150 km to the southeast.

Three large open water bodies are located in the Isaac upper catchment, namely Lake Elphinstone, Teviot Creek Dam and Burton Gorge Dam (**Figure 1-6**). Lake Elphinstone is a natural lake formed behind the Carborough Range, whereas Teviot Creek Dam and Burton Gorge Dam are man-made structures that supply water to Burton and North Goonyella mines in the upper catchment.

Other than along the ranges, most of the Isaac River catchment has been cleared for agriculture and mining. There are several existing coal mines in the catchment, including Burton, North Goonyella, Goonyella Riverside,

Broadmeadow, Broadlea North, Isaac Plains, Moranbah North, Millennium, Daunia, Poitrel, Grosvenor, Peak Downs, Saraji, Norwich Park and Lake Vermont mines.

Vulcan South is located in the headwaters of the Boomerang, Hughes, Barrett and Harrow creek catchments (**Figure 1-7**):

- Boomerang Creek, which is a watercourse and tributary of the Isaac River, drains the northern portion of the Vulcan South area;
- Hughes Creek is a watercourse and tributary of Boomerang Creek and drains the majority of the southern Vulcan South area;
- Barrett Creek, which is a watercourse and tributary of Hughes Creek, drains a small portion of the southern Vulcan South area; and
- headwaters of Harrow Creek, which is a tributary of Cherwell Creek and the Isaac River, drain a small portion of the northern Vulcan South area.

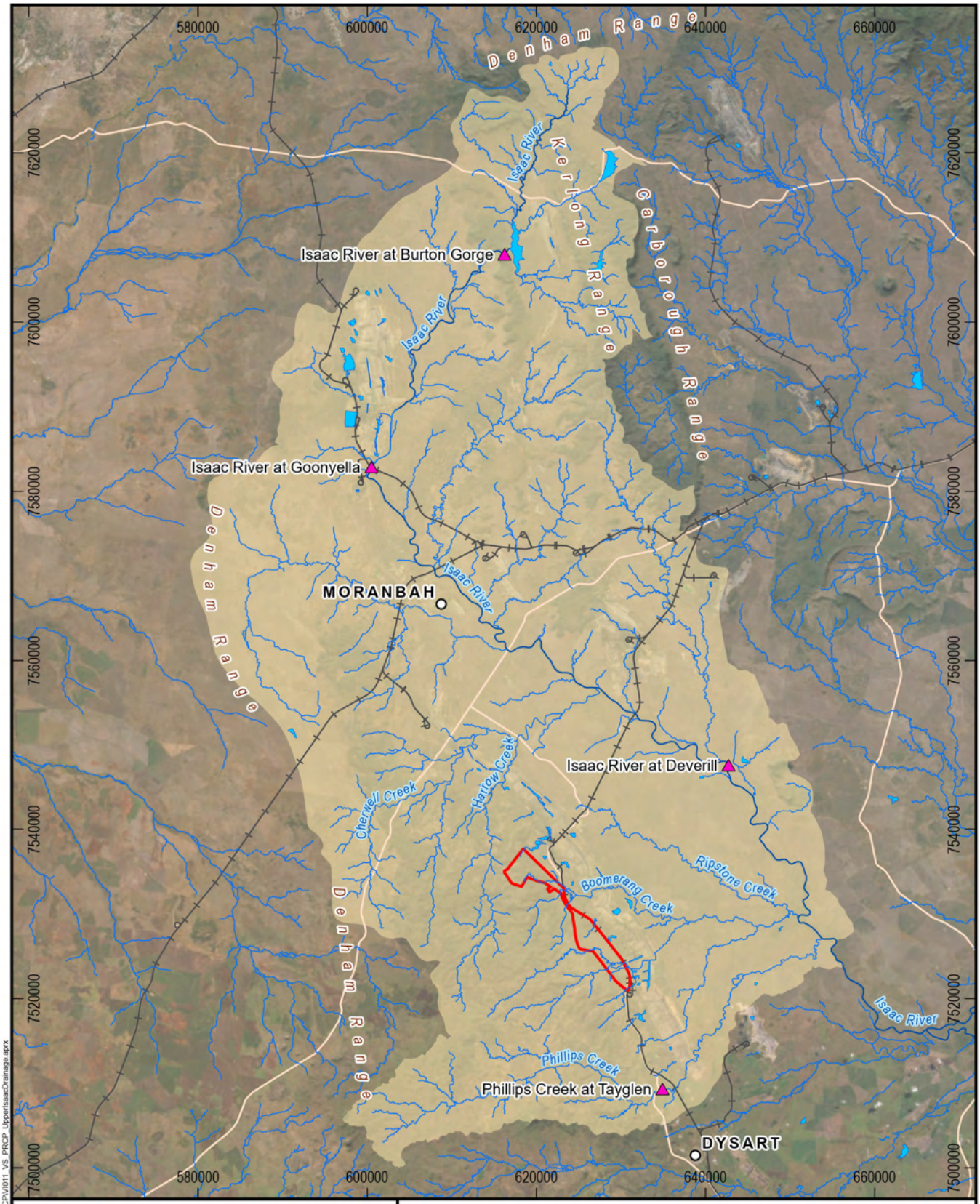
The confluence of Boomerang and Hughes Creek occurs 10 km east of Vulcan South. Boomerang Creek drains into the Isaac River 10 km to the east of Vulcan South.

The catchment area of the Isaac River to Boomerang Creek is approximately 5,226 km^2. The catchment area of Boomerang Creek is 788 km^2, of which 177 km^2 makes up the Hughes Creek catchment.

The catchments of Boomerang Creek, Hughes Creek and Barrett Creek commence to the west of the Vulcan South area and drain in an easterly direction towards Saraji Road and the Norwich Park Branch Railway. The Ripstone Creek catchment lies to the north of the Vulcan South area and drains into Boomerang Creek 30 km southeast of Vulcan South. The headwater tributaries of Boomerang and Hughes Creek are ephemeral streams that experience flow only after sustained or intense rainfall.

The predominant catchment land uses of Boomerang Creek include undeveloped areas with stock grazing to the west of Saraji Road and stock grazing and coal mining to the east. Boomerang Creek, Hughes Creek and Barrett Creek flow into the existing BHP Billiton Mitsubishi Alliance (BMA) operations (Peak Downs and Saraji). The existing BMA operations have diverted the original alignment of Boomerang Creek and its tributaries, as well as Harrow Creek to the north. Additional diversions of Boomerang Creek and its floodplain are also planned for approved operations further to the east.

A small portion of Vulcan South MLA area (in the far northwest) lies within the Harrow Creek catchment (**Figure 1-7**). Harrow Creek flows in a northerly direction. Sawmill Creek and Kennedy Creek are tributaries of Harrow Creek that are located upstream of the Vulcan South MLA area. Harrow Creek flows into Cherwell Creek, which in turn discharges into the Isaac River to the north of Vulcan South.



Legend

- Railway
- Road
- Isaac River
- Drainage Feature
- MLA Boundary
- DES Gauge
- Lakes / reservoirs
- Isaac River to Philips Creek

Source: State of Queensland (Department of Environment and Science 2020, Department of Resources 2021-2022), WRM 2020, Vitrinite 2022, METServe 2022, Earthstar Geographics.

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_UpperIsaacDrainage.aprx

Vulcan South

Upper Isaac River Drainage Characteristics

0 5 10 20

Kilometers

Scale: 1:650,000 (A4)

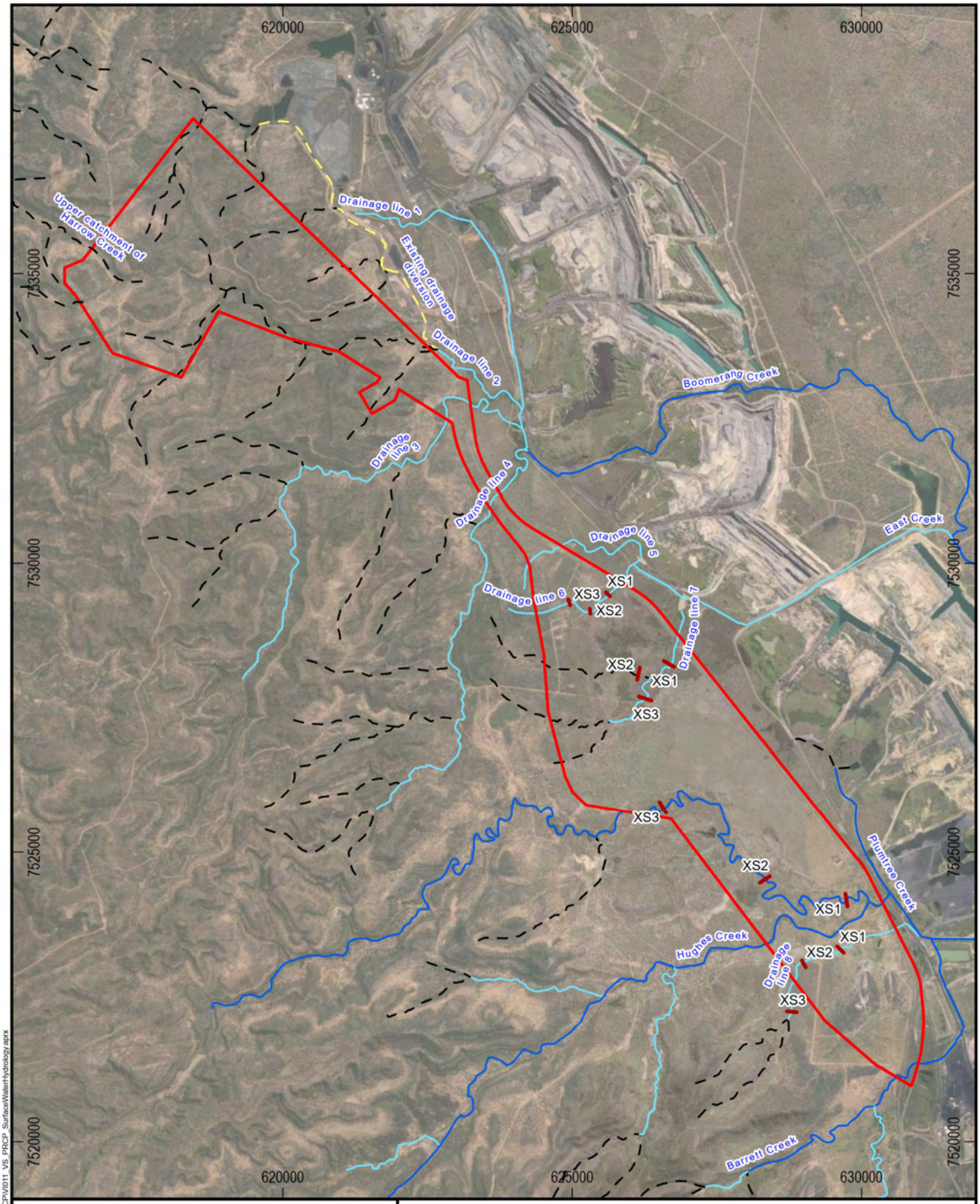
8/02/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-6

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

- Railway
- Cross sections
- MLA Boundary

Local Drainage Features

- Minor Drainage Features
- Drainage Features
- Drainage Diversion
- Watercourse

Source: WRM 2020, State of Queensland (Department of Resources) 2021-2022, Vitrinite 2022, METServe 2022, Earthstar Geographics.

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_SurfaceWaterHydrology.aprx

Vulcan South

Local Drainage Features

0 0.75 1.5 3

Kilometers

Scale: 1:95,000 (A4)

9/02/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-7

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Drainage features in the immediate vicinity of the Project are shown in **Figure 1-8**. Those drainage features that intersect mining areas are as follows:

- drainage line 1 (a tributary of Boomerang Creek);
- drainage line 2 (a tributary of Boomerang Creek);
- drainage line 6 (a tributary of Boomerang Creek);
- drainage line 7 (a tributary of Boomerang Creek);
- Hughes Creek; and
- drainage line 8 (a tributary of Hughes Creek).

These features are depicted in **Figure 1-9** to **Figure 1-11**, and their typical channel cross-sections, along with 1% AEP flood levels (i.e. a one in 100 year flood) are presented in **Figure 1-12**. Locations for the cross-sections are given in **Figure 1-10** and **Figure 1-11.**

Drainage lines 1 and 2 are tributaries of Boomerang Creek as shown in Figure 1-7. Minor drainage features that are tributaries of Drainage Line 2 drain most of the Highwall mining area (**Figure 1-9**). Drainage line 2 has a catchment area of approximately 30 km^2. Drainage Line 2 flows east beneath Saraji Road and the Norwich Park branch railway, to the east of the Project area, before discharging into the Peak Downs ML.

What was formerly the upper reaches of Drainage Line 1 now dive-rt (as a result of BHP's actions) along a mine levee wall and form part of the Drainage Line 2 catchment. A haul road is proposed to be constructed across Drainage Line 2 immediately upstream of where the diversion enters.

The typical dimensions of the Drainage Line 2 channel are (WRM, 2023):

- channel bed widths of 3 m to 5 m;
- channel top widths of 10 m to 30 m;
- channel depths 1 to 2 m; and
- overbank floodplain widths of 50 m to 150 m.

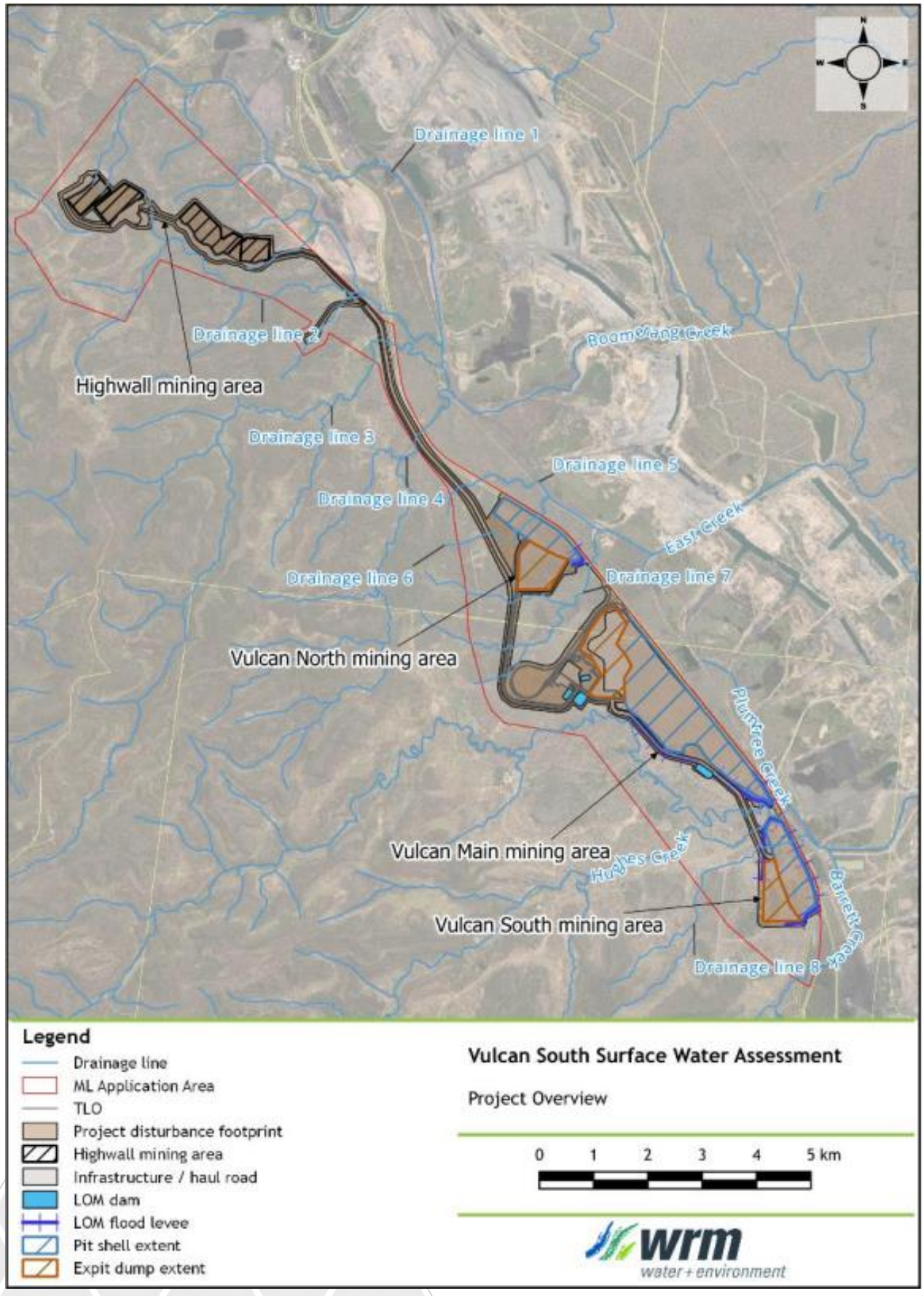


Figure 1-8 Project overview and drainage features (WRM, 2023)

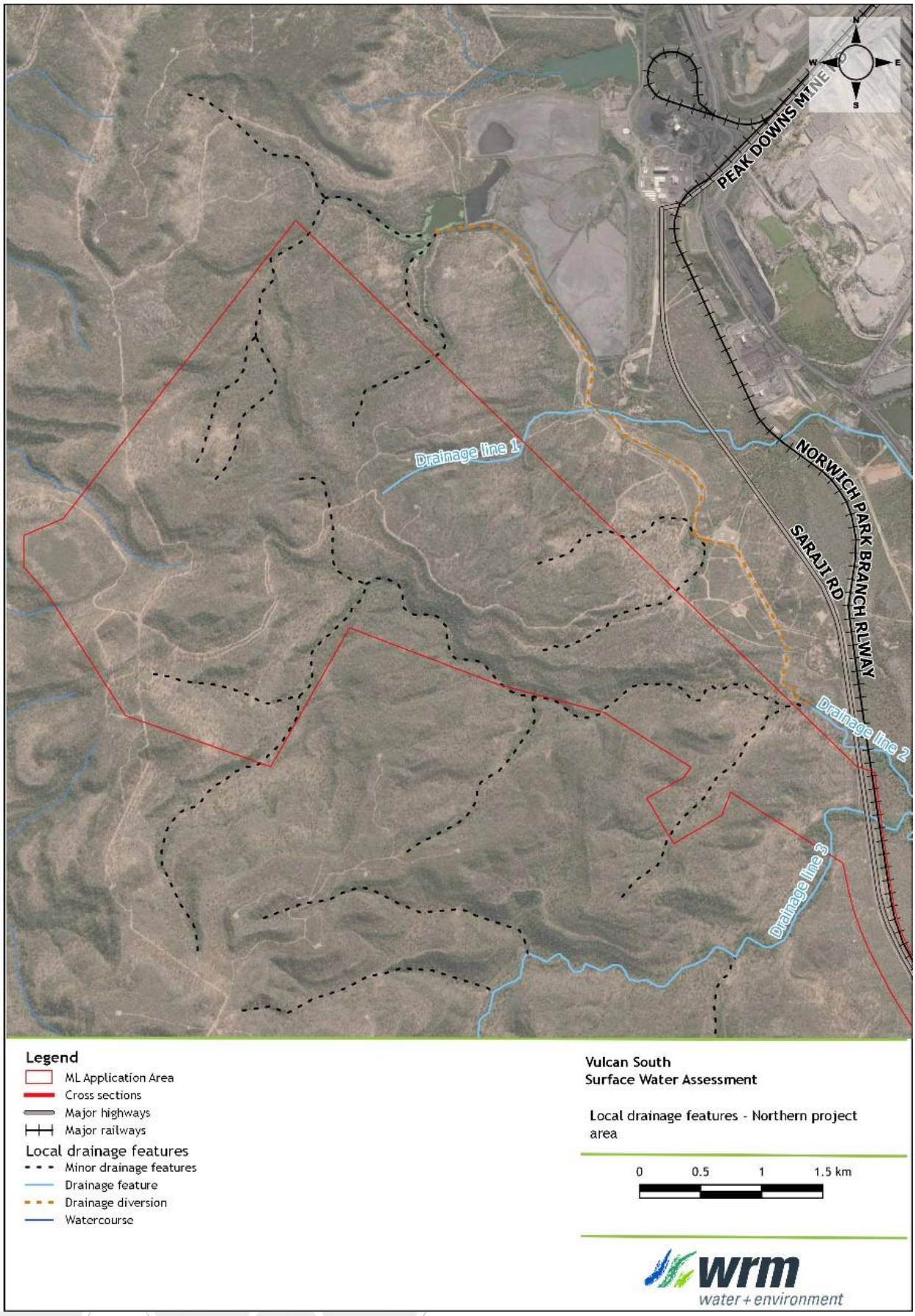


Figure 1-9 Local drainage features - northern Project area (WRM, 2023)

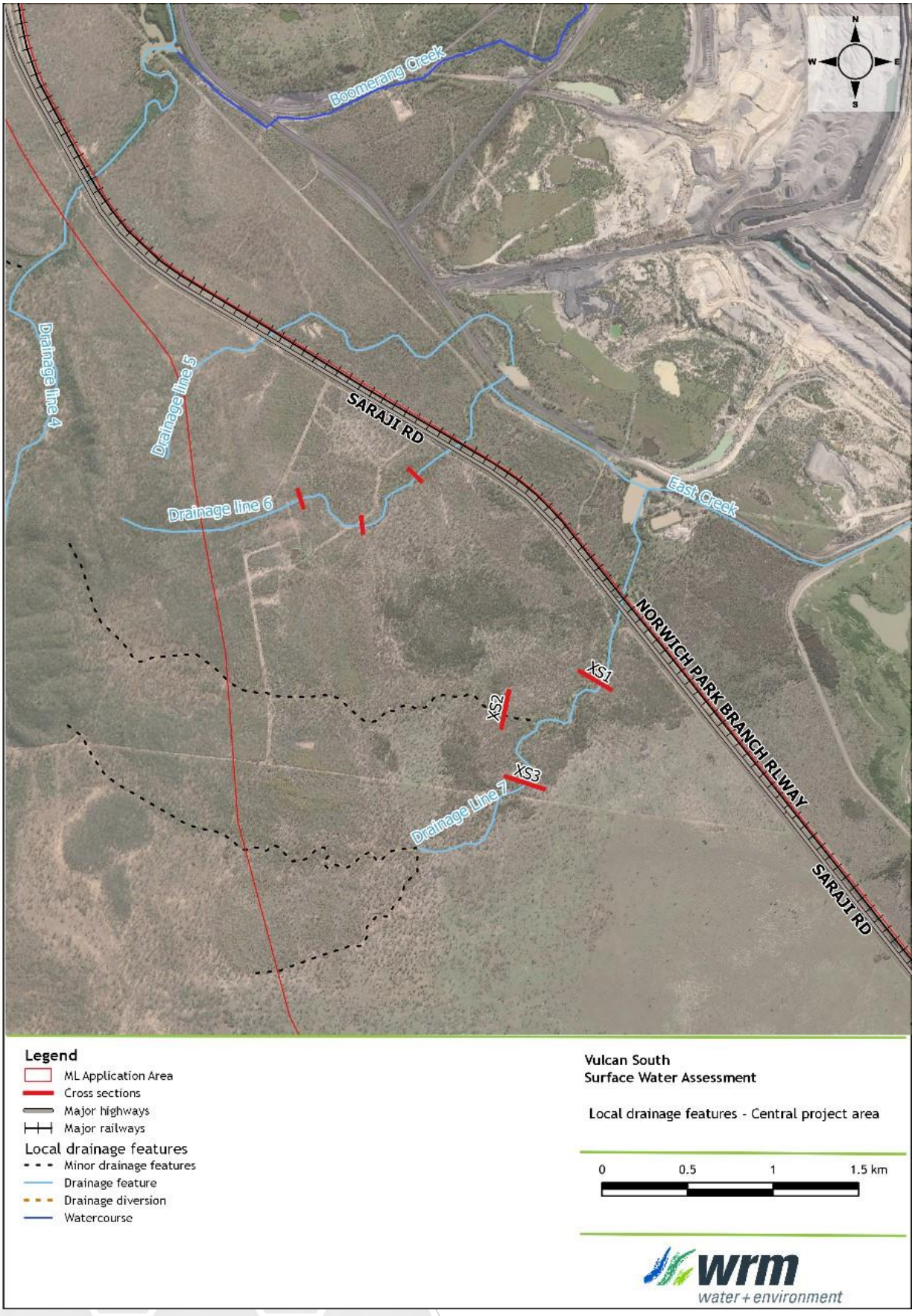


Figure 1-10 Local drainage features - central Project area (WRM, 2023)

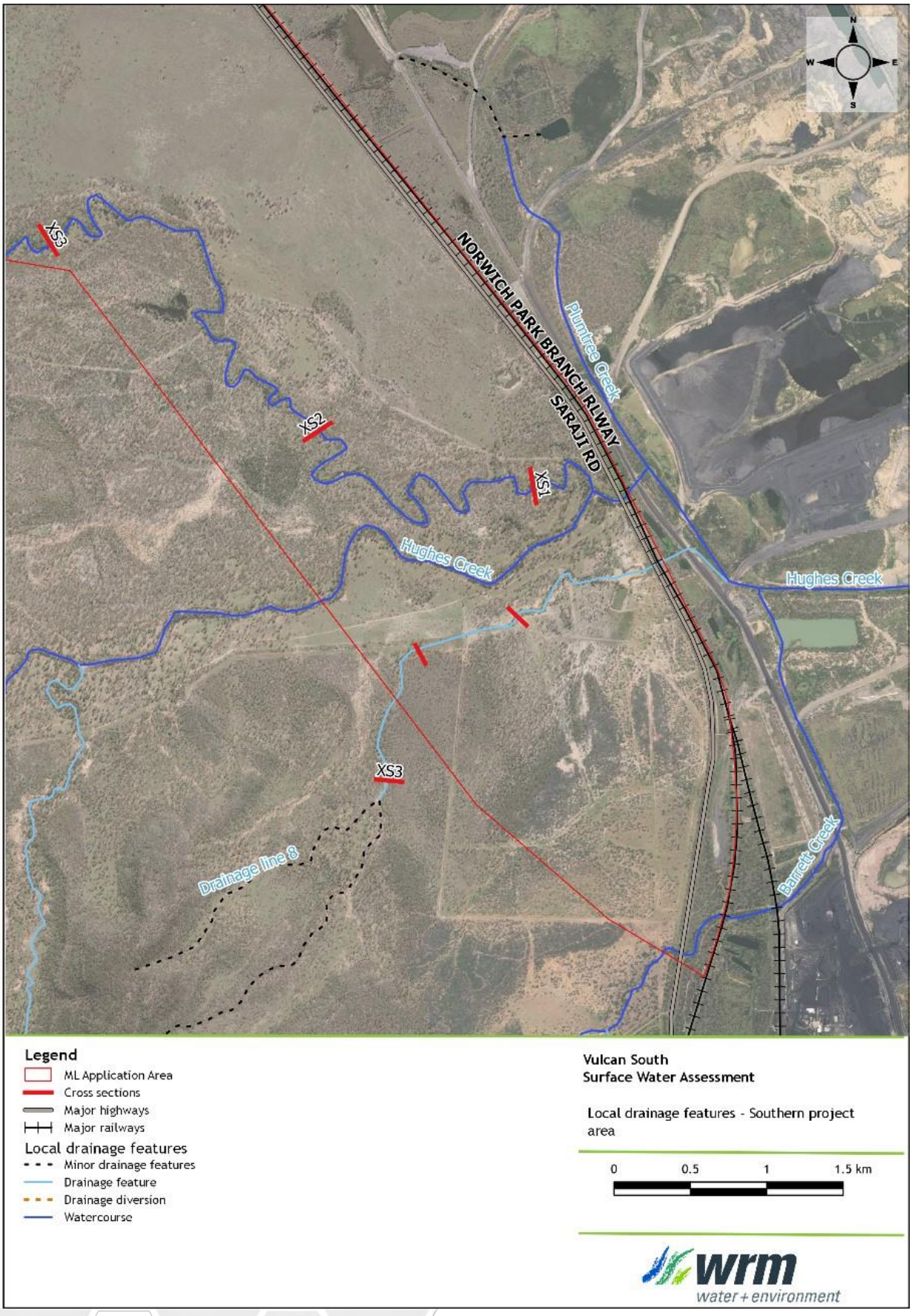


Figure 1-11 Local drainage features - southern Project area (WRM, 2023)

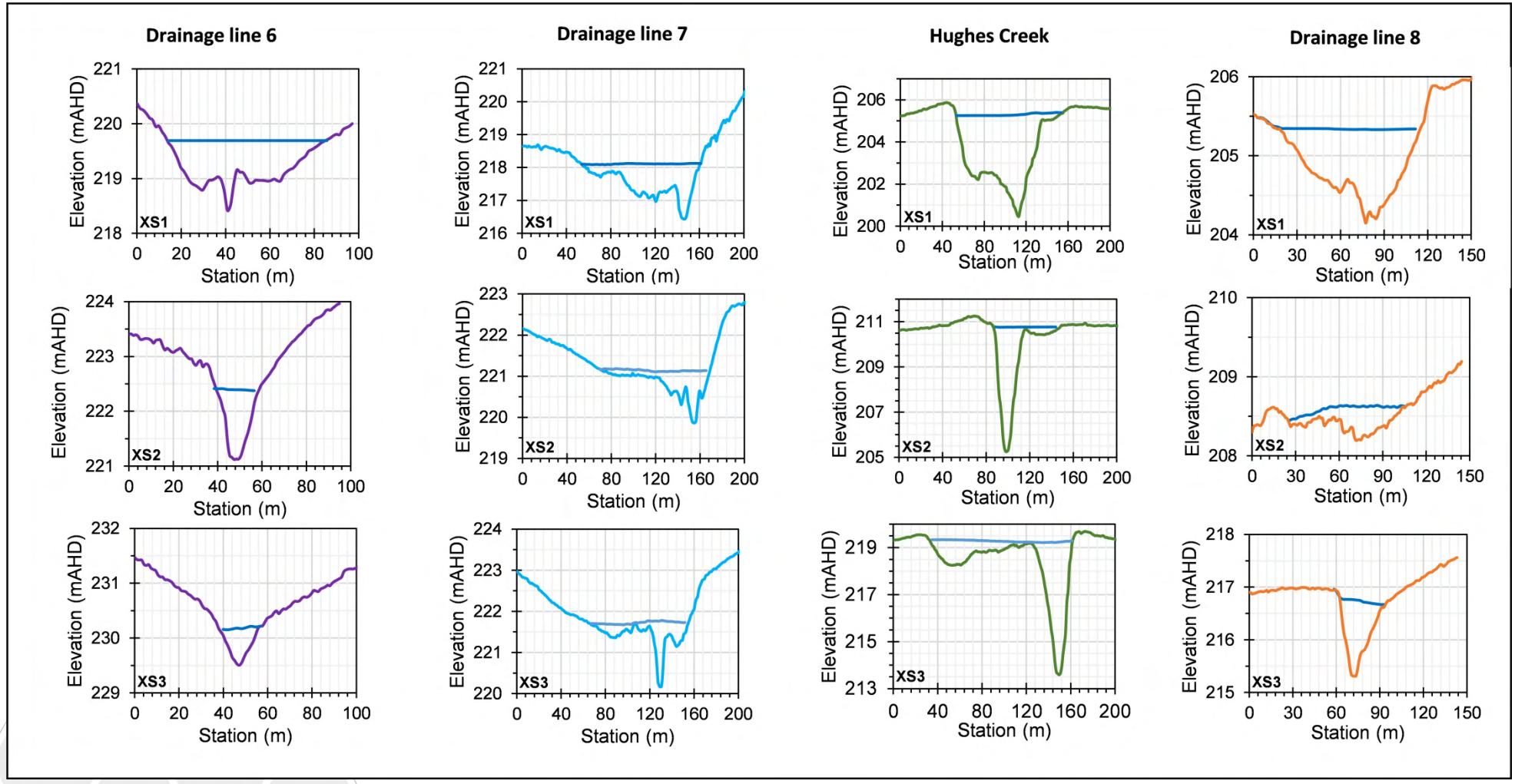


Figure 1-12 Drainage line cross sections with 1% AEP flood levels (WRM, 2023)

Tributaries of East Creek (i.e., Drainage Line 5, Drainage Line 6 and Drainage Line 7) drain the central parts of the Vulcan South MLA area. These drainage lines pass through culverts under Saraji Road and the Norwich Park branch railway within the Vulcan South area. These drainage lines merge to form East Creek on the eastern side of the railway. East Creek passes through the Saraji Mine operation before draining into Boomerang Creek approximately 5 km east of Vulcan South.

The typical dimensions of the Drainage Line 6 channel through the Vulcan South area are (**Figure 1-12**):

- channel bed widths of 1 m to 5 m;
- channel top widths of 5 m to 20 m;
- channel depths 0.5 to 1 m; and
- overbank floodplain widths of 15 m to 80 m.

The typical dimensions of the Drainage Line 7 channel through the Vulcan South area are (**Figure 1-12**):

- channel bed widths of 3 m to 5 m;
- channel top widths of 10 m to 15 m;
- channel depths 1.0 to 2.0 m; and
- overbank floodplain widths of 50 m to 100 m.

Drainage line 6 will be diverted as part of Vulcan South to avoid mining areas. The 1.8 km drainage diversion will divert Drainage line 6 into Drainage line 7 during operations. Drainage Line 6 will be reinstated post-mining by constructing a drainage corridor through backfilled spoil.

Hughes Creek is a watercourse with a largely natural catchment to the west of the Vulcan South area. The creek flows eastwards between proposed mining areas, passing under two bridge crossings of Saraji Road and the Norwich Park branch railway. A number of drainage features discharge into Hughes Creek downstream of the Vulcan South area, including Barrett Creek and Drainage line 8. Hughes Creek passes through the Saraji Mine operation before discharging to Boomerang Creek approximately 10 km east of the Vulcan South area. Hughes Creek has been diverted and significantly modified within the Saraji Mine.

The typical dimensions of the Hughes Creek channel within the Vulcan South area are (**Figure 1-12):**

- channel bed widths of 3 m to 10 m;
- channel top widths of 30 m to 50 m;
- channel depths 2 to 5 m; and
- overbank floodplain widths of 50 m to 150 m.

Drainage line 8 is a tributary of Hughes Creek which flows through the proposed Vulcan South mining area. Drainage line 8 currently passes through box culverts under Saraji Road and the Norwich Park branch Railway before discharging into Hughes Creek to the east of the Vulcan South area. Drainage line 8 is proposed to be diverted during operations around mining areas into Hughes Creek to the north. Drainage Line 8 will be reinstated post-mining by constructing a drainage corridor through backfilled spoil.

The typical dimensions of the Drainage Line 8 channel through/upstream of the Vulcan South area are (**Figure 1-12**):

- channel bed widths of 1 m to 3 m;
- channel top widths of 10 m to 20 m;
- channel depths 0.5 to 1.0 m; and
- overbank floodplain widths of 50 m to 150 m.

Drainage line 8 has been dammed in its lower reaches as a water source for livestock.

No stream flow data was available for East Creek or Hughes Creek at the time of the surface water assessment (**Appendix A**). Two streamflow gauges operated by the Department of Resources (DoR) in the vicinity of Vulcan South were identified as part of the surface water assessment and are located at:

- Isaac River at Deverill (approximately 25 km northeast of Vulcan South); and
- Phillips Creek at Tayglen (approximately 15 km southeast of Vulcan South).

Sediment covers the bottom metre of the stream flow gauge on the Isaac River. In an average year, surface flow above the sediment occurs primarily in wetter months (November-August) with only shallow, sub-surface flows the rest of the year. Phillips Creek is characterised by brief periods of flow interspersed by long periods of no flow. This ephemeral behaviour is typical for streams in this part of the Fitzroy Basin. Further detail of stream flow investigation at these sites is provided in **Appendix A**.

Surface Water Quality

Regional and local water quality has been investigated as part of the surface water assessment (**Appendix A**). Full datasets are available for the Deverill Gauging Station on the Isaac River between 2011 and 2018 (**Table 1-2**). The water quality at the Deverill Gauging Station compares to Water Quality Objectives (WQO) in the following ways:

- the Electrical Conductivity (EC) values for high flows greater than 200 m^3/s are generally below the high flow WQO of 250 µs/cm;
- the EC of flows below 100 m^3/s vary significantly from 50 µS/cm to 1,870 µS/cm, and frequently exceed the low flow WQO of 720 µS/cm.
- the mean daily EC has exceeded the low flow WQO on a total of 23 days over this period, and all of these days experienced some flow (not stagnant flow); and
- stream flows are highly ephemeral with surface flows ceasing within a few days or weeks of a runoff event.

Further discussion of regional water quality can be found in **Appendix A**.

Table 1-2 Water quality of the Isaac River at Deverill (WRM, 2023)

Parameter	Unit	Median value at Deverill	WQO default guideline value
Aluminium - Total	mg/L	-	< 5 (stock)
Aluminium - Dissolved	mg/L	0.05	< 0.055 (aquatic)
Boron - Total	mg/L	0.06	< 5 (stock)
Calcium - Dissolved	mg/L	16	-
Chloride - Total	mg/L	32	-
Copper - Dissolved	mg/L	0.03	< 0.0014 (aquatic)
EC	µS/cm	261	< 720 (baseflow) < 250 (high flow)
Filterable Reactive Phosphorus	µg/L	0.35	< 20 (aquatic)
Fluoride - Total	mg/L	0.14	< 2 (irrigation)
Iron - Dissolved	mg/L	0.06	-
Manganese - Dissolved	mg/L	0.01	< 1.9 (aquatic)
Nitrate - Total	mg/L	1.4	-
Nitrogen - Total	µg/L	0.76	< 500 (aquatic)
pH	-	7.6	6.5-8.5 (aquatic)
Phosphorus - Total	µg/L	0.35	< 50 (aquatic)
Potassium - Total	mg/L	4.55	-
Sodium - Total	mg/L	22	< 30 (drinking water)
Sulphate - Total	mg/L	10.9	< 25 (aquatic)
Total Alkalinity	mg/L	78	-
Total Dissolved Solids	mg/L	155	< 2,000 (stock)
Total Suspended Solids	mg/L	135	< 55 (aquatic)
Turbidity	NTU	247	< 50 (aquatic)
Zinc - Dissolved	mg/L	0.01	< 0.008 (aquatic)

Local water quality sampling has been undertaken as a component of the baseline surface water quality sampling in early 2020 (**Appendix A**). Analyses for a comprehensive range of physio-chemical parameters were completed at the monitoring sites.

The baseline monitoring locations in addition to the full suite of baseline monitoring undertaken for Vulcan South is presented in **Appendix A**. Monitoring results from the sites most relevant to Vulcan South have been reviewed as part of the surface water assessment (**Appendix A**) and suggest that certain baseline water quality values surrounding Vulcan South do not meet the WQO for the region, these include:

- Aluminum (filtered and total);
- Zinc (filtered);
- Iron (filtered and total);
- Turbidity;
- Total Nitrogen;
- Total Phosphorous;
- Chlorophyll a; and
- Hydrocarbons

To establish local water quality objectives, the Queensland Water Quality Guidelines (QWQG) require that with 3 or more reference sites, 12 samples are collected over at least 12, but preferably 24 months. Vitrinite has established more than 12 reference sites that have been monitored for more than 3 years, which meets the QWQG requirements collected from February 2020 to March 2023, which will continue to be either upstream reference

sites or reference sites until mining commences. However, data collection is limited to periods of flow in an ephemeral system.

Baseline Flooding

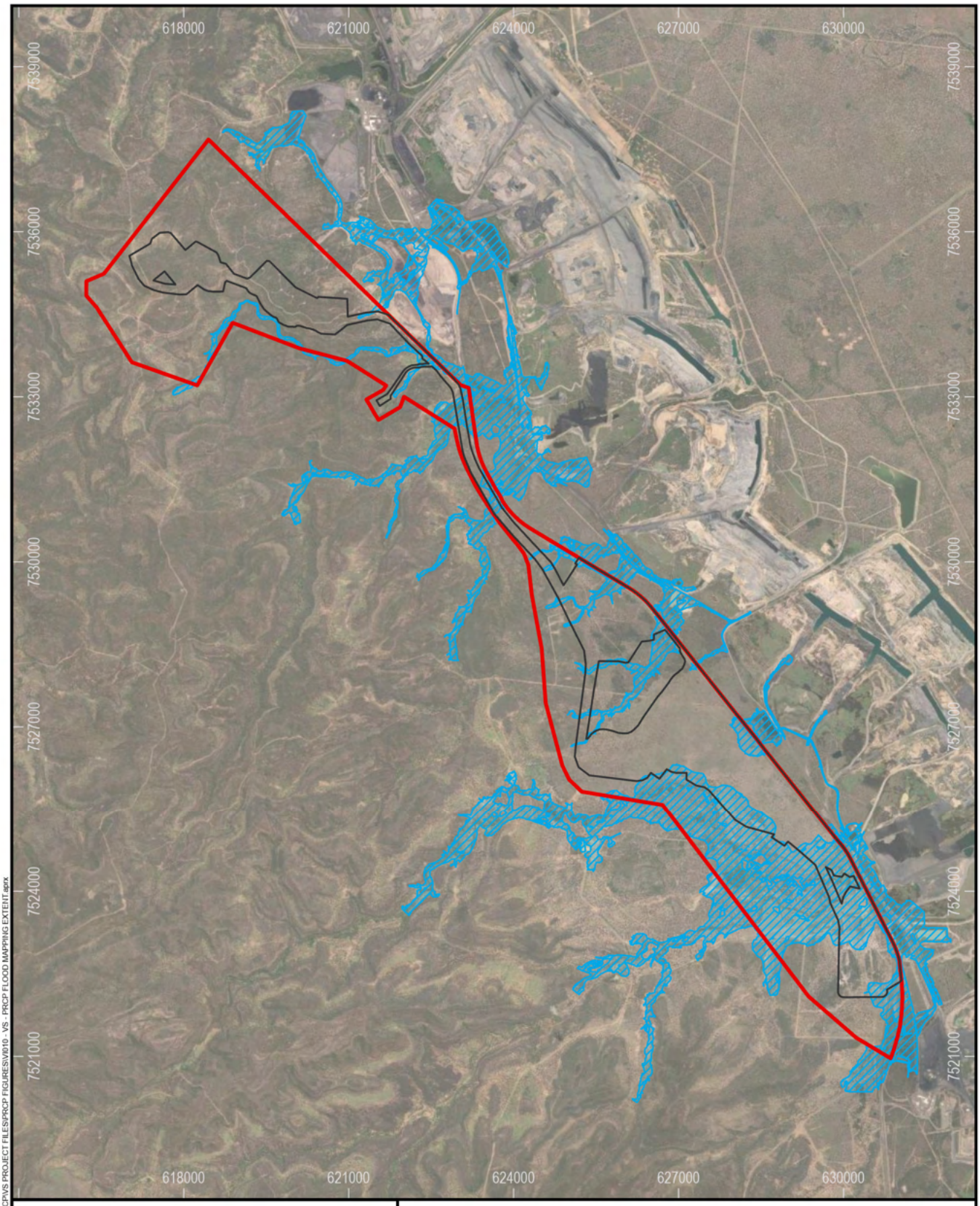
In accordance with Section 126D(3) of the EP Act, any voids situated wholly or partly within a flood plain must be rehabilitated to a post-mining land use (PMLU) with a stable condition. While no non-use management areas (NUMAs) are proposed for Vulcan South, flood plain modelling was undertaken as part of baseline assessments, to inform flood risks during operations and rehabilitation. The flood modelling undertaken, its design, methodology, results, and mapping are presented in detail in **Appendix A**. This flood plain modelling revealed that small parts of the disturbance footprint for the Project occur within a flood plain (**Figure 1-13**), as defined based on pre-mining conditions.

The baseline flooding conditions for the 10% AEP, 1% AEP and 0.1% AEP scenarios are as follows:

- East Creek:
  - For the 10% AEP event:
    - floodwaters through the Vulcan South area are generally conveyed within the channel banks of natural drainage lines. Saraji Road is overtopped at some crossing locations. The Norwich Park Branch Railway culverts have sufficient flow capacity to convey the 10% AEP event;
    - peak flood velocities along natural drainage channels in the vicinity of the Vulcan South area are up to 2.0 m/s in localised areas; and
    - overbank flood depths adjacent to natural drainage lines are generally shallow (less than 0.5 m).
  - For the 1% AEP event:
    - floodwaters through the Vulcan South area are generally conveyed within the channel banks of natural drainage lines with limited overbank flooding. Saraji Road is overtopped at most crossing locations. The Norwich Park Branch Railway culverts have sufficient flow capacity to convey the 1% AEP event;
    - peak flood velocities in natural drainage channels exceed 2.0 m/s in localised areas. Overbank velocities are generally up to 1 m/s; and
    - flood widths and depths adjacent to natural drainage lines are greatest upstream of Saraji Road and Norwich Park Branch Railway where floodwaters are impounded behind the constructed embankments.
  - For the 0.1% AEP event:
    - floodwaters through the Vulcan South area are generally conveyed within the channel banks of natural drainage lines with confined overbank flooding;
    - flood velocities along natural drainage channels are typically elevated (greater than 2.5 m/s in localised areas). Overbank velocities are generally up to 1 m/s; and
    - peak flood widths and depths along the eastern side of the Vulcan South area increase as natural drainage lines drain towards Saraji Road and Norwich Park Branch Railway where floodwaters are impounded behind the constructed embankments. Flood depths impounded behind the railway embankment at the eastern boundary of Vulcan South are up to 5 m.
- Hughes Creek:
    - For the 10% AEP event:
    - floodwaters through the Project area are generally conveyed within the Hughes Creek channel. Minor breakouts occur along the Drainage line 8 and Barrett Creek channels upstream of Saraji Road. The Norwich Park Branch Railway culverts have sufficient flow capacity to convey 10% AEP events;
    - peak flood velocities along natural drainage channels in the vicinity of the Vulcan South area exceed 2.0 m/s in localised areas. Overbank velocities are generally up to 1 m/s; and

- overbank flood depths adjacent to natural drainage lines are generally shallow (less than 0.5 m). Notwithstanding this, Hughes Creek flood depths are up to 3 m upstream of the railway.

- For the 1% AEP event:
  - overbank flooding occurs at several locations within the Vulcan South area along Hughes Creek, with flood widths of up to 1.6 km just upstream of the railway;
  - overbank flood depths are up to 4.5 m adjacent to Hughes Creek upstream of the railway. The railway embankment is overtopped during this event; and
  - peak flood velocities along natural drainage channels are typically elevated (up to 3.2 m/s in localised areas). Overbank velocities are generally up to 1.5 m/s.
- For the 0.1% AEP event:
  - significant overbank flooding occurs along Hughes Creek within the Vulcan South area along Hughes Creek and Barrett Creek, with flood widths of up to 2 km;
  - overbank flood depths are up to 5 m adjacent to Hughes Creek, with some localised areas that exceed 5 m; and
  - peak flood velocities along natural drainage channels are typically elevated (up to 4 m/s in localised areas). Overbank velocities are generally up to 2.0 m/s.



Legend

- MLA Boundary
- Maximum Disturbance Footprint
- 0.1% Annual Exceedence Probability (AEP) Peak Flood

Source: State of Queensland (Department of Resources) 2021, METServe 2020-2023, WRM 2022, Earthstar Geographics.

Vulcan South

Flood Mapping Extent

0 2 4

Kilometers

Scale: 1:100,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-13

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\VS PROJECT FILES\PRCP FIGURES\V6010 - VS - PRCP FLOOD MAPPING EXTENT.aprx

1.2.6 Hydrogeology

In the vicinity of the Project, all geological formations yield low volumes of groundwater and hence would not typically be classified as aquifers in most hydrogeological settings. However, as individual lithological units within these formations have higher hydraulic conductivities than the intervening units, and groundwater in these formations was assessed for the determination of impact, they are referred to as aquifers for the purposes of this assessment. A detailed hydrogeological impact assessment has been carried out by hydrogeologist.com.au for Vulcan South and is provided in **Appendix B.** This is summarised below.

The following geological formations within the Project area may contain groundwater:

1) Quaternary alluvium: Confined to discrete channels in the beds of existing watercourses. These alluvial sediments are unsaturated and disconnected laterally.
2) Tertiary sediments and weathered regolith: Silts and clays, which comprise the bulk of the regolith overlying the coal measures, are densely compacted, hard and generally dry. Sand and gravel lenses embedded within the regolith are permeable but have low hydraulic conductivity and limited lateral and vertical extent. These have a potential to represent unconfined to confined aquifers, depending on location.
3) Permian coal measures: The ALEX and DLL coal seams are poor aquifers of low hydraulic conductivity. They are confined above and below by low-permeability regolith and sedimentary rocks. Nevertheless, these represent the largest and uppermost aquifers across most of the Project.
4) Back Creek Group: This formation of sandstones, siltstones and shale forms a largely impervious layer beneath the DLL coal seam aquifer. However, the Back Creek Group also contains narrow coal seams that can act as poor aquifers.

Hydrogeologist.com.au (2019) established a groundwater monitoring network across the Project area in June 2019 to support the Project (**Appendix B**). The groundwater monitoring network was equipped with data loggers to enable high frequency (daily) groundwater level measurements to be captured. On-going monitoring and sampling of the groundwater monitoring network is being carried out to further supplement the groundwater level and quality data included in the groundwater impact assessment (**Appendix B**). The monitoring and sampling of the groundwater monitoring network is planned for and carried out in consideration of the Queensland Monitoring and Sampling Manual (Department of Environment and Science, 2018).

The rationale of the monitoring network is to capture groundwater flow upstream and downstream of the Project, as well as provide data to the north and south. Permian coal measures and Tertiary sediments are the targets of the monitoring network as no Quaternary alluvium was identified within the study area (hydrogeologist.com.au, 2022). The monitoring bore network has been designed to also monitor other Vitrinite projects, such as the abutting VCM, and data gathered through the lifetime of the VCM will provide hydrogeological data for Vulcan South.

Proximity of adjacent mining operations restricts bore placement, particularly for off-lease downstream monitoring. Some of the established groundwater monitoring bores for baseline groundwater investigation are in future Vulcan South mining areas and as such will be replaced during the Project.

Groundwater Quality

The pH of local groundwater is neutral to slightly acidic (hydrogeologist.com.au 2022). Groundwater is brackish to highly saline (electrical conductivity of 2,700 to above 20,000 µS/cm) (hydrogeologist.com.au 2022). This is driven mostly by high concentrations of sodium and chloride (with moderate bicarbonate in some samples). This groundwater is generally unsuitable for irrigation, but it may be used in limited quantities as water for livestock. Electrical conductivity above 7,463 µS/cm is associated with decline in animal health if consumed for prolonged periods (ANZG 2018). All groundwater on site fails to meet guidelines for drinking water suitability for humans. Overall, groundwater on site has no or limited value for most uses, with the exception of limited stock watering and potential industrial purposes related to mining.

An assessment of groundwater use in the vicinity of Vulcan South (hydrogeologist.com.au, 2022) found that mining, petroleum and gas use is by far the most common, followed by water supply (for mining and also private use) then exploration and monitoring purposes. Other nearby groundwater bores are also brackish to highly saline (**Appendix B**).

Surface-groundwater interaction.

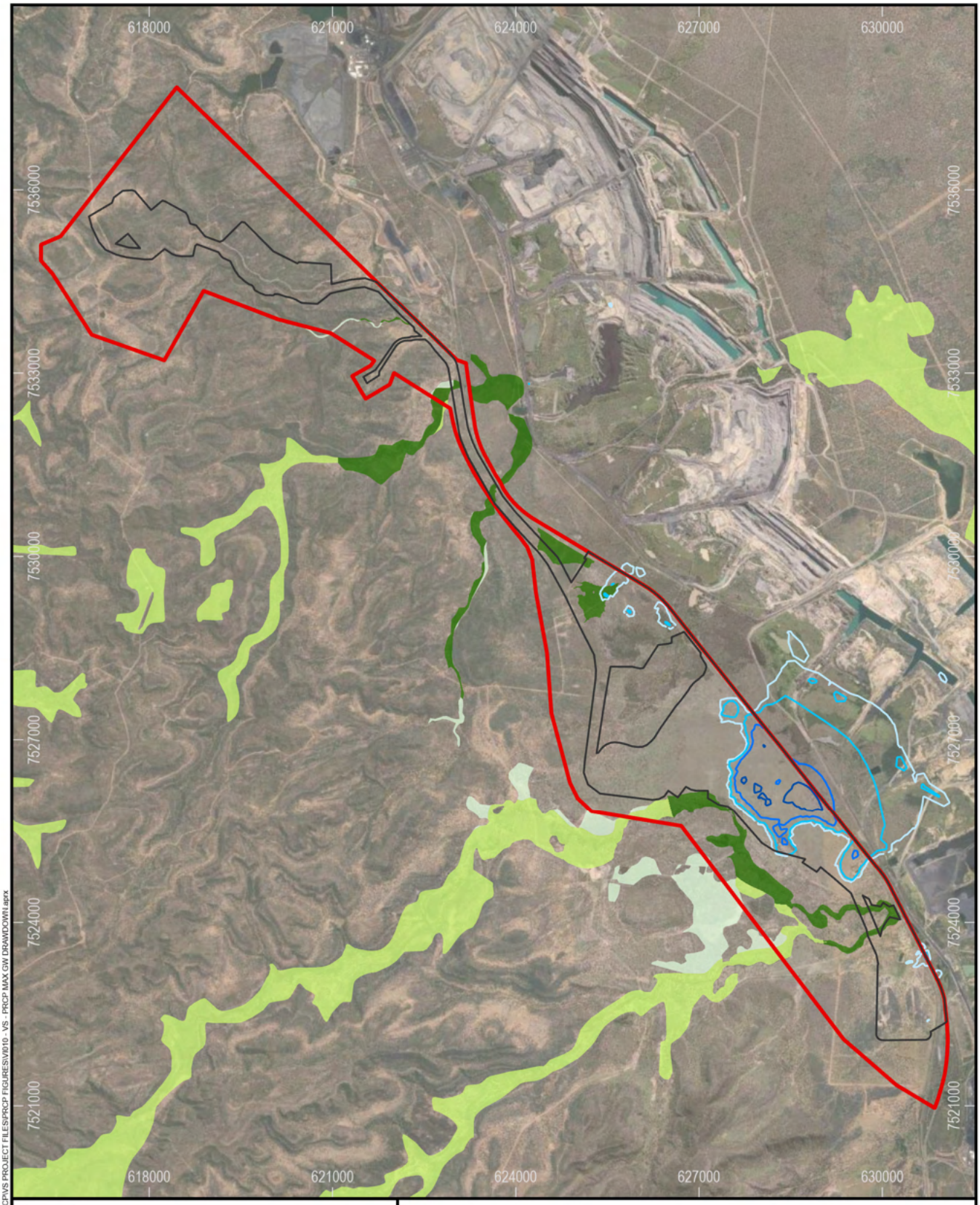
A desktop assessment of potential interaction between surface water and groundwater has been conducted (hydrogeologist.com.au, 2022) on the basis of the Project's surface water and groundwater regimes and comparison with similar investigations conducted at similar projects.

This assessment determined that due to the ephemeral nature of surface water systems in the Project area, creeks are dry for most of time, and, if present, the Quaternary alluvium would be unsaturated. The groundwater table occurs in the Tertiary sediments or the Permian coal measures at depths greater than 10 m below ground level. It was determined that a significant layer (>10 m) of unsaturated material occurs between surface water features and the groundwater table. Therefore, it is considered that there is no significant interaction between surface water and groundwater in the vicinity of the Project.

Groundwater Dependent Ecosystems

Aquatic Groundwater Dependent Ecosystem (GDE) mapping was conducted by hydrogeologist.com.au (2022). Small pockets of high- and moderate-potential aquatic GDEs mapped as occurring within the maximum drawdown associated with the Vulcan South pits are probably erroneous. This is because aquatic GDEs with high or moderate potential for groundwater interaction are most likely to occur in areas where the seasonally high groundwater potentiometric heads are above or close to the corresponding surface water level. This is necessary to maintain a hydraulic gradient from the groundwater to surface water, or at least to have a hydraulically connected system. Within or adjacent to the Project, the surface water systems is hydraulically disconnected from the groundwater system. In addition, groundwater in the Project area is brackish to saline, which contrasts markedly to the quality of local surface water (hydrogeologist.com.au, 2022).

Terrestrial GDE mapping (terrestrial regional ecosystems that are potentially dependent on groundwater) was conducted by METServe (2022) (**Figure 1-14**). No remnant vegetation outside the Project footprint is found within the zone of drawdown. Furthermore, any non-remnant vegetation within this zone is highly disturbed by existing mining operations. The groundwater quality is unlikely to be significantly altered by Vulcan South, and all local potentially groundwater-dependent ecosystems occur up-gradient of potential effects.



Legend

- MLA Boundary
- Maximum Disturbance Footprint

Groundwater Dependent Ecosystems

- High potential GDE
- Moderate potential GDE
- Low potential GDE

Predicted Drawdown (m)

- 1m
- 2m
- 5m
- 10m

Source: Hydrogeologist.com 2020, Vitrinte 2022, METServe 2022, Earthstar Geographics.

Vulcan South

Maximum Drawdown of Groundwater Predicted

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-14

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

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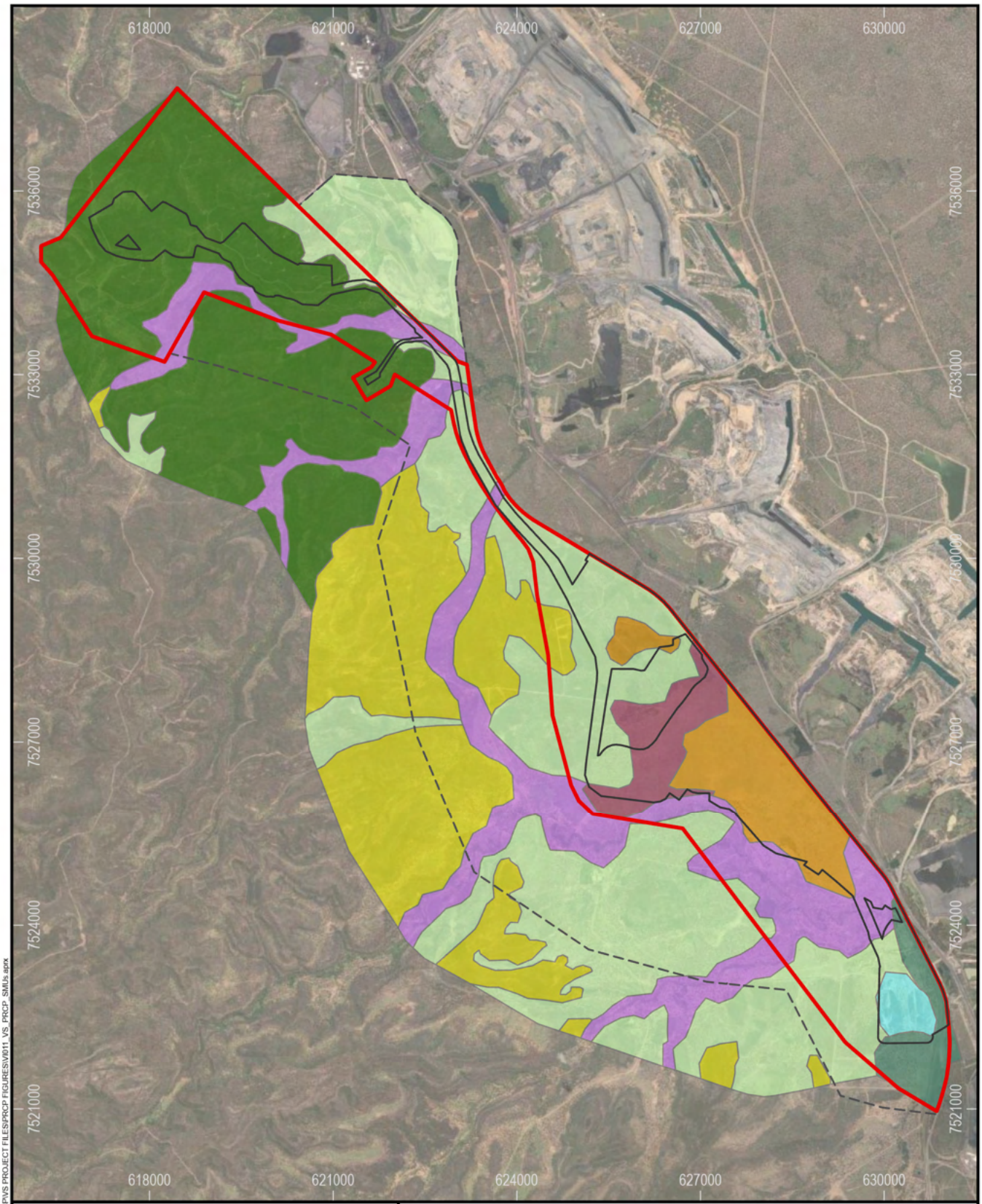
1.2.7 Soil

A Soil and Land Suitability Assessment of Vulcan South has been carried out by AARC (**Appendix C**). This is summarised below.

The *Report on Lands of The Isaac-Comet Area* (Story *et al.* 1967), mapped at a scale of 1:500,000, indicates the Project area contains the following land system units:

- Carborough Land System: The Carborough Land System is characterised by mountains and hills with broken and dissected local relief ranging between 30 m to 400 m. Structural benches and cliffs are common landforms with severe weathering occurring in some areas. This mountainous land system has formed shallow, coarse-textured, rocky soils. A small area of the Carborough Land System is also characterised by lower slopes and hills and alluvial flats with a local relief between 10 m to 60 m. Texture-contrast soils have formed in these areas and possess a thick sandy topsoil. Geology in this land system is comprised of partly weathered, quartz sandstone.
- Connors Land System: The Connors Land System is characterised by alluvial plains composed of terraces and levees up to 3 km wide. Texture-contrast soils have developed in this area, which are characterised by a thick sandy topsoil and neutral to strongly alkaline subsoil.
- Cotherstone Land System: The Cotherstone Land System is characterised by hills and prominent strike ridges as well as gentler undulating terrain associated with low indefinite strike ridges and colluvial foot slopes. The more prominent strike ridges possess a local relief varying between 10 m to 30 m and have developed shallow course-textured to rocky soils. The gentler undulating terrain has a local relief of less than 15 m and is associated with texture-contrast soils with a sandy upper-horizon. The geology in this land system is weathered Permian sandstone and shale.
- Monteagle Land System: The Monteagle Land System is predominantly characterised by low-lying plains and colluvial foot slopes with local relief generally below 6 m. This land system is associated with texture-contrast soils composed of a thick sandy topsoil and neutral to strongly alkaline subsoils. Geology in this land system is comprised of undissected Tertiary sandstones and clays.

Mapping at a scale of 1:85,000, based on soil surveys undertaken on site, identified eight soil management units (SMUs) within the Project MLA area (**Figure 1-15**). These are described in the following subsections.



Legend

- MLA Boundary
- Maximum Disturbance Footprint
- Survey Boundary

Soil Management Units

- Crocodile
- Fish
- Kei
- Komati
- Limpopo
- Orange
- Sabie
- Zambezi

Source: AARC Environmental Solutions 2019, Vitrinite 2022, METServe 2022, Earthstar Geographics.

Vulcan South

Soil Management Units of Vulcan South

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-15

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

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Crocodile SMU

This unit contains shallow, rocky soils associated with hill slopes and plateaus. Soils are classed as arenic rudosols. Soil textures grade from surface loams to loamy sands with depth. Soils often contain rock material with little to no pedologic development throughout the solum. The Crocodile SMU belongs to the Carborough land System and the Back Creek Geological Group.

The Crocodile SMU is strongly acidic throughout the solum with only a minor increase in pH at depth. It has very low salinity. Soils in this SMU are non-sodic and not dispersive (Emerson Class 7 or 8). The topsoil is dominated by sand (52%) and gravel (30%), with 10% silt and 8% clay. This coarse texture limits the soil's water-holding capacity and extractable nutrient levels, with soils being deficient in phosphorus, nitrates, sulphates, copper and zinc.

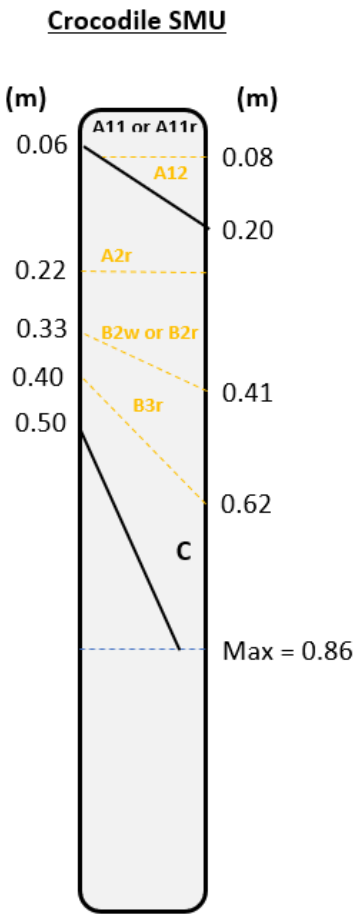
The Crocodile SMU typically has the following soil profile:

The **surface soil** (A11/A11r/A12) is a black to very dark greyish brown (10YR2/1, 10YR3/2) sand to sandy loam with loose to weak polyhedral structure with some profiles containing moderately strong to strong sub-angular rock material. The soil unit has a field pH of 4.5 - 5.5, demonstrating an abrupt to clear change to;

The **lower surface soil** (A2r) is not a common horizon observed for this SMU. It is a dark brown (10YR3/3) loamy sand with an abundance (comprising 50 - 90% of this horizon) of moderately strong coarse fragments approximately 2 - 6 cm in diameter. It has loose structure and a field pH of 5.5 to 5.0. Gradual change to;

The **subsoil** (B2w/B2r) is a dark greyish to reddish brown (10YR3/2, 2.5YR2.5/4) loamy sand to clay loam with weak to moderate polyhedral structure. It can contain rounded to angular course fragments which make up < 10% of the horizon. This horizon has a field pH of 4.5 to 5.5, with a gradual change to;

The **lower profile** (C) contains either consolidated or unconsolidated partly weathered rock material that appears to have originated from underlying sandstone and siltstone, with some profiles possessing an overlying transitionary horizon (B3r). Depending on the rock material present, this horizon can range from dark red to light yellow-brown colour.



Fish SMU

Occurring in flats on the south-eastern side of the study area, the Fish SMU is a grey kurosol. The Fish SMU belongs to the Cotherstone Land System and is part of the Back Creek Group. It is moderately permeable.

The Fish SMU is moderately to strongly acidic and increases in acidity with depth. Some pH values are below 5.5, which indicate a potential risk of aluminium toxicity. Salinity (EC) is observed to be very low throughout the profile, as are chloride values. Soil is generally nutrient-deficient. Below 10 cm, the SMU is sodic and at risk of dispersion.

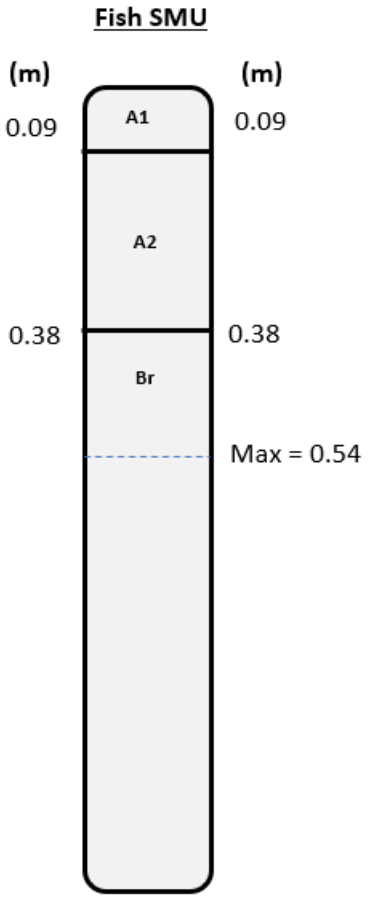
Fish SMU topsoil is dominated by sand (60%), with some silt (20%), clay (15) and gravel (2%). Organic matter content is moderate.

The Fish SMU typically has the following soil profile:

The **surface soil** (A1) is a dark-grey (10YR4/1), loamy sand with weak platy structure, and the deeper horizons exhibit diffuse red to orange mottling. It has a field pH of 5.5 to 6, demonstrating a clear change to;

The **lower surface soil** (A2) is a grey (10YR5/1) clayey loam sand. This horizon has a weak polyhedral structure and a field pH of 5.5. Abrupt change to;

The **subsoil** (Br) is a grey (10YR5/1), silty clay loam with moderate polyhedral structure. This horizon has minor, indistinct, red and orange mottling with diameters of <1.5 cm. This horizon has a field pH of 4.5 to 5.5.



Kei SMU

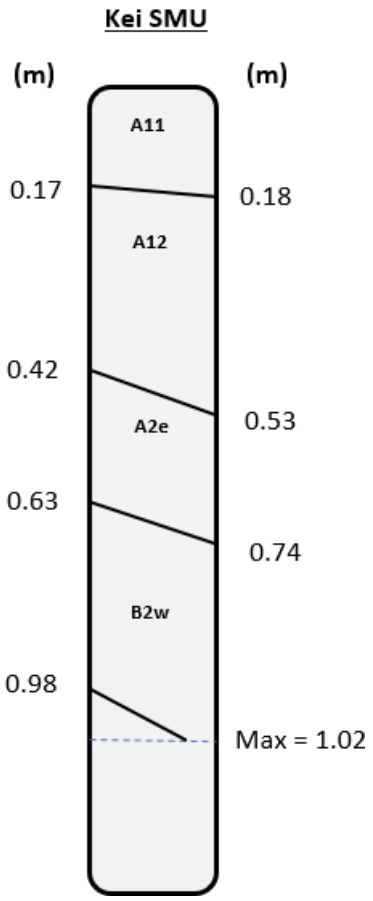
The Kei SMU is a brown chromosol occurring mostly in flats on the south-eastern side of the Project area. It belongs to the Cotherstone Land System and Back Creek Group. Its texture grades from clayey to loamy sands at the surface, to medium clay with depth. Orange to yellow mottling is observed in its deeper horizons.

The Kei SMU is moderately permeable. It is neutral to slightly acidic in its upper horizons and becomes neutral to slightly alkaline with depth. This alkalinity may be a limiting factor to plant growth at depth but not in the upper horizons. Salinity (EC) is very low to low (at depth), as is chloride. Dispersion is expected to be a low risk, as this SMU is non-sodic. The Kei SMU has low cation exchange capacity (CEC), reflecting infertility of the soil.

Particle size analysis shows that the topsoil of the Kei SMU is comprised of 62% sand, 25% silt, 12% clay and 1% gravel. Organic matter is 2.4% in the top 0-10 cm.

The Kei SMU typically has the following soil profile:

The **surface soil** (A11/A12) is a very dark greyish-brown to dark yellowish-brown (7.5YR3/2, 7.5YR3/4), clayey sand to sandy loam, with a loose to weak platy structure. It has a field pH of 6 to 7. This horizon gradually to diffusely changes to:



The **lower surface soil** (A2e) is a bleached brown (10YR4/4) loamy sand. This horizon has a loose structure and a field pH of 7-7.5. There is a clear to gradual change to:

The (B2w) is a dark greyish-brown (10YR4/2), silty clay loam to medium clay, with moderate-strength, polyhedral structure. This horizon has faint yellow and orange mottles with diameters of <1.5 cm. This horizon has a field pH of 7 to 7.5.

Komati SMU

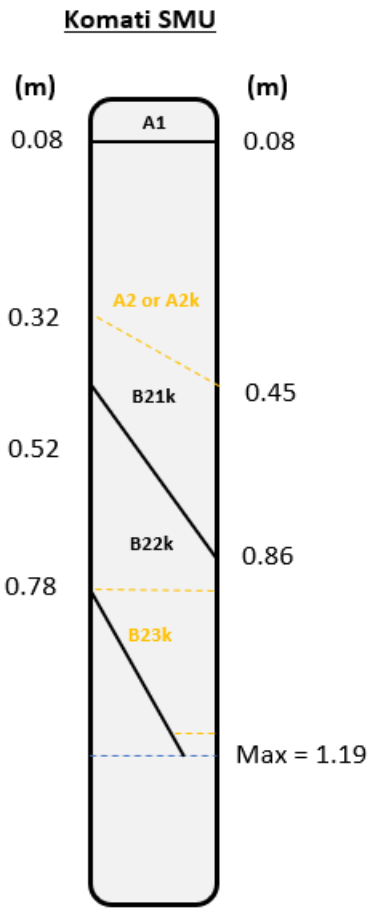
The Komati SMU is a brown vertosol belonging to the Monteagle Land System and is of Quaternary origin. It is a light to medium clay with calcareous segregations in deeper horizons. It is slowly permeable and is imperfectly to moderately well drained.

The Komati SMU is neutral at its surface but becomes strongly alkaline with depth, with pH values up to 9.5 in the subsoil. This higher pH may be a severely limiting factor in the availability of essential plant nutrients. EC values are low in upper horizons becoming high with depth. Likewise, chloride increases dramatically to the level of toxicity in the subsoil, potentially detrimentally interfering with plant osmosis.

Exchangeable sodium percentage increases with depth to highly sodic. However, the risk of dispersion is low due to the presence of calcium carbonate at depth.

The topsoil is observed to be comprised of 55% sand, 32 % clay, 11% silt, 2% gravel, and 2.7% organic matter. While non-sodic, the topsoil may be at risk of dispersion, indicated by an Emerson class number of 3 and a calcium/magnesium ratio of 1:2. Extractable nutrient content is poor in surface soil.

The Komati SMU typically has the following soil profile:



The **surface soil** (A1) is black to a very dark brown (7.5YR2.5/1, 7.5YR3/3), sandy clay loam to light medium clay, with a polyhedral structure of moderate strength. It has a field pH of 7 to 8.5. This horizon clearly and abruptly changes to:

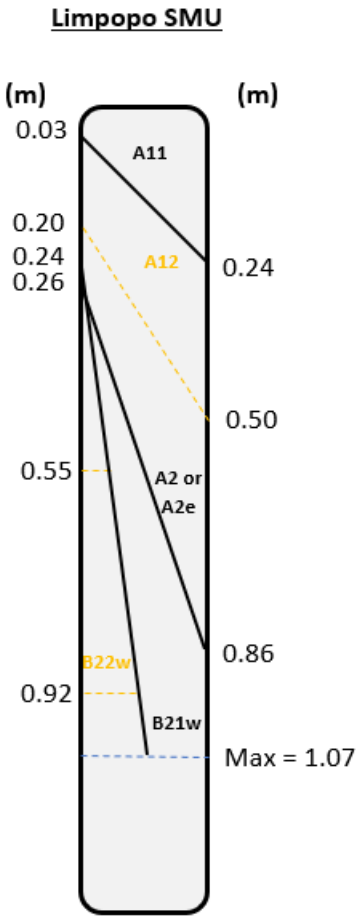
The **lower surface soil** (A2 or A2k), which was not observed in all profiles of this SMU, is a brown to very dark brown (7.5YR4/4, 10YR2/2), light medium to medium clay, with a moderately strong, polyhedral structure and a field pH of 8 to 8.5. Some profiles display a minor occurrence (<10%) of calcareous segregations. There is a clear to gradual change to:

The **subsoil** (B21k, B22k, B23k) is separated into several B2 horizons depending on colour. However, all contain an abundance of calcareous segregations (20-50% of the horizon). Colours range from strong browns (7.5YR4/6, 7.5YR5/6) to browns and light browns 7.5YR4/4, 7.5YR6/4). The texture is a medium clay, with moderate-strength, lenticular to polyhedral structure. This horizon has a field pH of 8.5 to 9.

Limpopo SMU

This is a brown, texture-contrast soil unit. Soils are classed as brown sodosols. Soil textures grade from sands to clay sands in the surface soils to light clays in deeper horizons. The Limpopo SMU belongs to the Monteagle land System and the Back Creek Geological Group.

The Limpopo SMU has a moderately acidic soil profile (pH 5.5-5.6). Salinity levels are very low. Sandy surface soils are non-sodic and not vulnerable to dispersion. However, clay subsoils (below 0.5 m) are sodic and susceptible to dispersion. The topsoil is dominated by sand (79%) with 8% silt and 10% clay. This texture may be at risk of slumping. Soils are deficient in phosphorus, nitrates, potassium, copper, zinc and boron.



The Limpopo SMU typically has the following soil profile:

The **surface soil** (A11, A12) is brown to a dark-brown (7.5YR4/4, 7.5YR3/3) sand to loamy sand with a loose structure. It has a field pH that ranges between 5 and 6, with a clear to gradual change to:

The **lower surface soil** (A2 or A2e) is a brown to greyish brown (7.5YR4/4, 10YR5/2), with some profiles within this soil unit displaying bleaching in this horizon (A2e). Predominant textures observed in this horizon range from sandy loams to sandy clay loams, with a loose to weak polyhedral structure and a field pH of 6. There is a clear to gradual change to:

The **subsoil** (B21w, B22w) includes dark yellowish-brown to a dark greyish-brown (10YR4/4, 10YR4/2) clayey or sandy loams and light clays with weak- to moderate-strength polyhedral structure. Mottling was often observed in this horizon, with colours ranging between red, orange and yellow. This horizon has a field pH of 5.5 to 7.

Orange SMU

The Orange SMU is comprised of dark, cracking clay, associated with the flat grassy plains in the middle of the Project area. It belongs to the Monteagle Land System and is of Quaternary origin. Soils predominantly range from light clays in surface soils to light medium clays in deeper horizons. The SMU is classified as a grey vertosol and is slowly permeable.

High pH values characterise the Orange SMU, ranging from 8.1 in the topsoil to 9.6 in the subsoil. These values may restrict plant nutrient availability. EC values increase from low in the topsoil to high in the subsoil. Below 0.2 m depth, the soil is prone to dispersion.

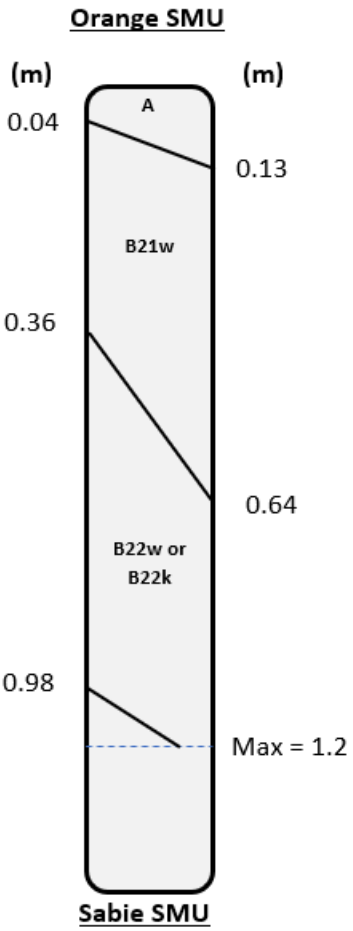
Topsoils comprise 51% sand, 28% clay, 19% silt, and 2% gravel, with 3.6% organic material. Topsoils are not considered at risk of dispersion and have good structural stability. Topsoils have limited nutrient availability. Manganese concentrations are so high as to the point of possible plant toxicity.

The Orange SMU typically has the following soil profile:

The **surface soil** (A) is black (10YR2/1, 2.5Y2.5/1), light clay, with moderate lenticular structure. It has a pH of 6 to 7. This horizon abruptly changes to:

The **upper subsoil** (B21w) is a black to a very dark grey (10YR2.5/1, 2.5Y3/1), light medium clay with strong lenticular structure and a field pH of 7.5 to 8.5. There is a clear to diffuse change to:

The **lower subsoil** (B22w/B22k) is a very dark grey (10YR3/1, 2.5Y3/1), light medium to medium clay, with strong lenticular structure. This horizon has a field pH of 8.5 to 9.



Sabie SMU

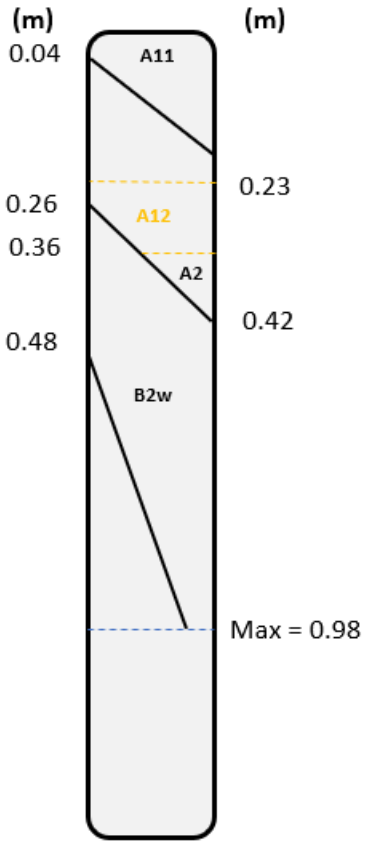
The Sabie SMU is a red sodosol comprised of dark, texture-contrast soils, consisting of sandy topsoil over a clay subsoil. It belongs to the Scarborough Land System and the Back Creek Group. Deep horizons contain red to orange mottles. Permeability is moderate.

Surface soils of the Sabie SMU are strongly acidic (pH <5) down to 0.3 m depth. This potentially restricts plant nutrient availability and increases the risk of aluminium toxicity. Below this, soils are less acidic and do not pose the same issues. EC of the SMU is low, as is chloride concentration. Subsoils can be strongly sodic, posing a high risk of dispersion.

The topsoil contains 75% sand, 12% clay, 10% silt and 3% gravel. It has a loose, single grain to weak platy structure, with high organic matter content (4.1%). Topsoils are not at risk of dispersion. Phosphorus is low in topsoils, but all other nutrients are present at suitable concentrations for plant growth. Iron concentrations are high and may pose a toxicity risk to plants.

The Sabie SMU typically has the following soil profile:

The **surface soil** (A11/A12) is black to very dark brown (2.5YR2.5/1, 7.5YR2.3/3), sand to loamy sand, with loose to very weak platy structure. It has a field pH of 5 to 7. This horizon clearly and abruptly changes to:

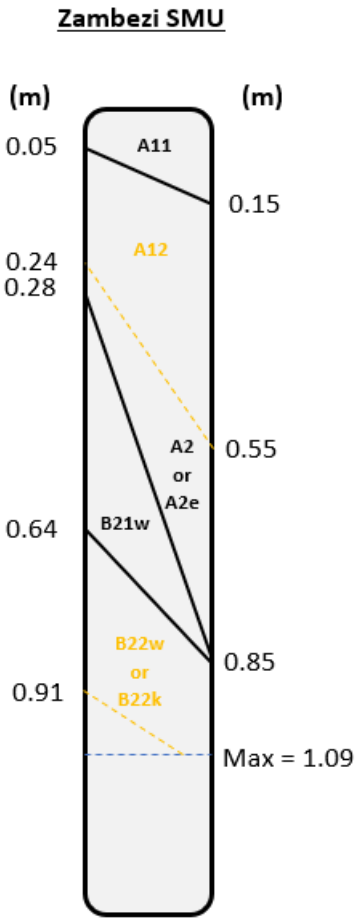


The **lower surface soil** (A2) is a brown to a dark reddish-brown (7.5YR4/4, 5YR3/3), clayey sand to sandy clay loam, with loose or very weak polyhedral structure, and a field pH of 5-6. There is a clear to gradual change to:

The **lower subsoil** (B2w) is a dark reddish-brown to dusky red (5YR3/3, 2.5Y3/2), clayey loam to medium clay, with moderate polyhedral structure. This horizon has a field pH of 5 to 6.

Zambezi SMU

This unit contains grey, texture-contrast soils, with a sandy surface and clay subsoil. Lower horizons display diffuse orange to yellow mottles. Soils are classed as grey sodosols. The Zambezi SMU belongs to the Cotherstone Land System and the TQa geological formation (late-Tertiary to Quaternary poorly consolidated alluvium).



The Zambezi SMU has a slightly acidic (pH 6.4 to 6.7) topsoil (to 0.3 m deep), which becomes progressively alkaline with depth (to pH 9 at >0.8 m depth). Salinity levels are low throughout the soil profile. The subsoil is strongly sodic and the risk of dispersion is high below 0.3 m depth (Emerson Class 2). The topsoil is dominated by sand (77%), with 14% silt, 9% clay and <1% gravel. It has a loose to weak platy structure, and low organic matter content (2%). Soils are deficient in nitrates, sulphates, phosphorus, copper and zinc.

The Zambezi SMU typically has the following soil profile:

The **surface soil** (A11/A12) is dark brown to very dark greyish-brown (7.5YR2.2.5/5, 10YR3/2), coarse-grained, loamy sand with loose to very weak platy structure. It has a field pH of 5.5 to 7. There is a clear and abrupt change to:

The **lower surface soil** (A2/A2e) is a brown to greyish-brown (7.5YR5/4, 10YR5/2), loamy sand, with some profiles displaying this as a bleached horizon with loose single-grained structure and a field pH of 6 to 7.5. There is a clear and abrupt change to:

The **lower subsoil** (B21w and B22w/B22k) is a light grey to grey (10YR7/2, 7.5YR6/1) clayey loam sand to silty clay loam with moderate polyhedral structure. This horizon has a field pH of 7 to 9.

1.2.8 Land Stability

The subsoil of most SMUs identified in the Vulcan South area (**Section 1.2.7**) exhibit some degree of dispersive behaviour, which has the potential to result in erosion when exposed through the clearing of vegetation, stripping or stockpiling of topsoil, and construction of infrastructure, unless management methods are implemented (AARC, 2022). Some of the soil units have a predisposition to stability issues in their baseline state, with gully erosion widespread along minor drainage lines where grazing intensity is highest.

1.2.9 Vegetation

A Terrestrial Ecological Assessment of Vulcan South has been carried out by METServe (**Appendix D**). The Project area contained a variety of remnant, regrowth and cleared vegetation types. The sandstone ranges in the highwall portion of Vulcan South (in the north-west) mostly support remnant vegetation dominated by *Corymbia citriodora, Corymbia aureola, Eucalyptus crebra, Corymbia trachyphloia, Eucalyptus melanophloia* and *Acacia shirleyi.* On the plains that comprise most of the Project area, sandy areas are dominated by woodlands of *Eucalyptus crebra, Eucalyptus melanophloia, Eucalyptus populnea* and/or *Corymbia clarksoniana.* Clay soils supported patches of *Acacia harpophylla, Casuarina cristata* and/or *Eucalyptus cambageana*, although most of this had been cleared for grazing. One patch of clay in the centre of the Project area supported open, grassy woodlands dominated by *Eucalyptus orgadophila.* Watercourses and major drainage lines supported a fringe of *Eucalyptus camaldulensis, Melaleuca leucadendra* and/or *Melaleuca fluviatilis.* Fourteen regional ecosystems occurred (as remnant and/or regrowth) in the Project area (**Table 1-3, Figure 1-16**).

Heavy grazing was a notable feature of plains within the Vulcan South area. This manifested through the altered composition of the understorey vegetation (Fensham *et al*. 1999; Walker *et al*. 2006). Native perennial grasses were scarce, while introduced pasture grasses (especially *Cenchrus ciliaris*, *Bothriochloa pertusa*, *Melinis repens* and *Urochloa mosambicensis*) dominated, along with native annual species (e.g., *Alloteropsis cimicina*, *Setaria surgens*, *Dactyloctenium radulans*, *Perotis rara*).

The threatened ecological community listed as "Brigalow (*Acacia harpophylla* dominant and co-dominant)" were contained within the Project area. This was the only threatened ecological community present. This community included remnants and high-quality regrowth of the constituent regional ecosystems, 11.4.8 and 11.4.9.

Two other vegetation communities present on site possessed attributes similar to listed threatened ecological communities but did not meet the criteria for these listed communities. Of these, the "Poplar Box Grassy Woodland on Alluvial Plains" did not achieve a sufficient condition class to qualify as a threatened ecological community due to being dominated by weeds. A small patch of vine thicket near the highwall component of Vulcan South did not qualify as "Semi-evergreen Vine Thickets of the Brigalow Belt (North and South) and Nandewar Bioregions" as it was on an inappropriate sandstone geology.

A total of 429 species of vascular plants were recorded in or near the Project area. None of these are listed as threatened species. Of these, 56 species are non-native plants. The following weeds were most widespread, occurring at 30% or more of sampling sites:

- *Bothriochloa pertusa* (Indian Couch);
- *Sida spinosa* (Spiked Sida);
- *Cenchrus ciliaris* (Buffel Grass);
- *Melinis repens* (Natal Grass);
- *Portulaca pilosa* (Hairy Portulaca);
- *Stylosanthes scabra* (Shrubby Stylo); and
- *Urochloa mosambicensis* (Sabi Grass).

Seven species of weeds present within the survey area are category 3 restricted matters under the *Biosecurity Act 2014*, which prohibits their sale, trade or spread. These restricted weeds are:

- *Cryptostegia grandiflora* (Rubber Vine);
- *Harrisia martinii* (Harrisia Cactus);
- *Hymenachne amplexicaulis* (Olive Hymenachne);
- *Jatropha gossypiifolia* (Bellyache Bush);
- *Opuntia stricta* (Prickly Pear);

- *Opuntia tomentosa* (Velvet Pear); and
- *Parthenium hysterophorus* (Parthenium).

All of the above, except *H. martinii*, are also classed as Weeds of National Significance. While this classification does not introduce additional restrictions, it acts to coordinate management across states.

Table 1-3 Regional ecosystems present within the Vulcan South project area

Regional Ecosystem	BVG*	Short description	VM class†	Biodiv. Status‡	Hectares within project area	
					Remnant	Regrowth
11.3.2	17a	*Eucalyptus populnea* woodland on alluvial plains	OC	OC	55.4	63.9
11.3.7	9e	*Corymbia* spp. woodland on alluvial terraces	LC	OC	31.3	0
11.3.25	16a	*E. camaldulensis* forest fringing drainage lines.	LC	OC	71.9	2.0
11.3.27e	34d	Open water freshwater wetland with fringing trees	LC	OC	6.5	0
11.4.8	25a	*Eucalyptus cambageana* woodland to open forest with *Acacia harpophylla* on Cainozoic clay plains.	E	E	124.5	4.0
11.4.9	25a	*Acacia harpophylla* shrubby woodland with *Terminalia oblongata* on Cainozoic clay plains.	E	E	13.9	0
11.5.3	17a	*Eucalyptus populnea* woodland on Cainozoic sand plains and/or remnant surfaces.	LC	NC	33.1	140.1
11.5.9	18b	*Eucalyptus crebra* and other *Eucalyptus* spp. and *Corymbia* spp. woodland on Cainozoic sand plains and/or remnant surfaces.	LC	NC	488.6	17.0
11.9.2	17b	*Eucalyptus orgadophila* woodland on fine-grained sedimentary rocks.	LC	NC	267.8	0
11.10.1	10a	*Corymbia citriodora* woodland on coarse-grained sedimentary rocks.	LC	NC	161	0
11.10.1x1	12a	*Corymbia aureola and Eucalyptus melanophloia open forest on scarps and sandstone tablelands.*	LC	NC	227.8	0
11.10.3	24a	*Acacia shirleyi* open forest on coarse-grained sedimentary rocks. Crests and scarps.	LC	NC	849.9	47.1
11.10.7	12a	*Eucalyptus crebra* woodland on coarse-grained sedimentary rocks.	LC	NC	181.9	10.3
11.10.8	7a	Semi-evergreen vine thicket in sheltered habitats on medium to coarse-grained sedimentary rocks.	OC	OC	1.3	0
Non-remnant	-	Cleared pasture, +/- scattered trees or young regrowth	-	-	1020.0	

*BVG = broad vegetation group

†VM class = classification under the *Vegetation Management Act 1999*: E = endangered, OC = of concern. LC = least concern.

‡Biodiversity status relates to environmentally sensitive areas under the *Environmental Protection Act 1994*: E = endangered, OC = of concern, NC = no concern at present.

618000 621000 624000 627000 630000

7539000 7536000 7533000 7530000 7527000 7524000 7521000

Legend

- Maximum Disturbance Footprint
- Survey Boundary
- MLA Boundary

Field-verified RE mapping

- 11.10.1
- 11.10.1x1
- 11.10.3
- 11.10.7
- 11.10.7/11.5.9
- 11.10.8
- 11.3.1
- 11.3.2
- 11.3.2/11.3.7
- 11.3.25
- 11.3.27c
- 11.3.27e
- 11.3.7
- 11.3.7/11.3.2
- 11.4.8
- 11.4.9
- 11.5.3
- 11.5.9
- 11.5.9/11.10.13
- 11.9.2
- HVR 11.10.13
- HVR 11.10.3
- HVR 11.10.7
- HVR 11.10.7/11.10.3
- HVR 11.3.2
- HVR 11.3.25
- HVR 11.4.8
- HVR 11.5.3
- HVR 11.5.3/11.3.2
- HVR 11.5.9

Source: Vitrinite 2022-2023, METServe 2020-2023, Earthstar Geographics.

Vulcan South

Field-verified Regional Ecosystem Map of Vulcan South

0 1 2

Kilometers

Scale: 1:60,000 (A3)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-16

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V8111_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\VS PROJECT FILES\PRCP FIGURES\V8110 - VS - PRCP FV REGIONAL ECOSYSTEMS.aprx

1.2.10 Threatened species

Field surveys of a 6,762-ha area surrounding and including the Project detected 41 species of mammal, 135 species of bird, 36 species of reptile, 14 species of frog and 429 species of vascular plants. Twenty-seven species of plants and animals listed as threatened species under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) were flagged by database searches as being potentially present in the region. An additional two threatened species protected under the *Nature Conservation Act 1992* (NC Act), but not the EPBC Act were flagged. The following five of these threatened species have been recorded within the Project area:

- Koala (*Phascolarctos cinereus*) (endangered under the EPBC Act and NC Act);
- Squatter Pigeon *(Geophaps scripta scripta*) (vulnerable under the EPBC Act and NC Act);
- Central Greater Glider (*Petauroides armilatus*) (endangered under the EPBC Act and NC Act);
- White-throated Needletail (*Hirundapus caudacutus*) (vulnerable under the EPBC Act and NC Act); and
- Glossy Black-Cockatoo (*Calyptorhynchus lathami*) (vulnerable under the NC Act).

Eleven additional threatened species are possible inhabitants or visitors to the Project area (**Table 1-4**).

Table 1-4 Threatened species of national and/or state environmental significance flagged by databases as being potentially present in the local region

Taxon	Species	Common Name	EPBC status*	NC status†	Habitat requirements	Presence in survey area‡	Presence in project area‡
Bird	*Geophaps scripta scripta*	Squatter Pigeon	V	V	Open grassy woodland near water, with areas of bare ground, on land zones 3, 5 and 7.	C	C
Mammal	*Phascolarctos cinereus*	Koala	E	E	Vegetation communities containing food trees (*Eucalyptus* spp.), especially near watercourses.	C	C
Mammal	*Petauroides armillatus*§	Central Greater Glider	E	E	Tall, old-growth eucalypt forest with tree hollows.	C	C
Bird	*Hirundapus caudacutus*	White-throated Needletail	V	V	Airspace containing flying insects, above a diversity of landscapes	C	C
Bird	*Calyptorhynchus lathami*	Glossy Black-Cockatoo	-	V	*Casuarina cristata* groves in Brigalow communities	C	C
Reptile	*Denisonia maculata*	Ornamental Snake	V	V	Gilgais on heavy clay soil, especially where *Acacia harpophylla* grows.	L	L
Reptile	*Egernia rugosa*	Yakka Skink	V	V	Potentially any vegetated habitat with fallen timber or rocks. There are no nearby records, but habitat is available locally.	P	P
Mammal	*Dasyurus hallucatus*	Northern Quoll	E	LC	Rugged escarpments in wetter forested areas.	P	P
Bird	*Rostratula australis*	Australian Painted-snipe	E	V	Freshwater wetlands with well-vegetated muddy edges.	P	P
Bird	*Erythrotriorchis radiatus*	Red Goshawk	V	E	Large tracts of undisturbed forest, especially near the ecotone between rainforests, melaleuca swamps and open eucalypt woodlands. Within the survey area, it is most likely in densely forested riparian habitats.	P	P
Grass	*Aristida annua*	Annual Wiregrass	V	V	Open eucalypt woodlands and pastures on basalt-derived clay. The survey area lies outside the known distribution of the species; the most northern record is 35 km south.	P	P
Mammal	*Macroderma gigas*	Ghost Bat	V	E	Primarily coastal ranges, where large cave systems occur near extensive forests. The nearest record is 85 km northeast.	P	P
Reptile	*Furina dunmalli*	Dunmall's Snake	V	V	Associated with *Acacia harpophylla* and eucalypt forests. The survey area is outside the known distribution of the species.	P	P
Reptile	*Lerista allanae*	Allan's Lerista	E	E	Inhabits root systems of grass tussocks growing on black clay soils.	P	P
Grass	*Dicanthium queenslandicum*	King Blue-grass	E	V	Grasslands or open woodland on clay soils, with low grazing pressure. Favourable soils within the survey area were subject to high grazing pressure.	P	P
Grass	*Dicanthium setosum*	Hairy Bluegrass	V	LC	Grasslands or open woodland on clay soils, with low grazing pressure.	P	P
Reptile	*Acanthophis antarcticus*	Common Death Adder	-	V	Forests with abundant litter, woody debris and rocks, especially in areas with few Cane Toads	P	P
Bird	*Calidris ferruginea*	Curlew Sandpiper	CE	E	Primarily coastal mudflats, but occasionally also uses the muddy margins of large freshwater wetlands.	U	U
Bird	*Grantiella picta*	Painted Honeyeater	V	V	Open woodlands, especially dominated by *Acacia harpophylla* or other *Acacia* species. They are dependent on an abundance of mistletoe, a resource that was scarce in the survey area.	U	U
Bird	*Neochmia ruficauda ruficauda*	Star Finch	E	E	Probably extinct in the Bowen Basin. Formerly inhabited grassy edges of rivers and wetlands.	U	U
Bird	*Poephila cincta cincta*	Southern Black-throated Finch	E	E	Grassy eucalypt forests, especially near water, where the understorey of native perennial grasses has not been compromised by grazing. No records within 100 km.	U	U

Taxon	Species	Common Name	EPBC status*	NC status†	Habitat requirements	Presence in survey area‡	Presence in project area‡
Mammal	*Nyctophilus corbeni*	Corben's Long-eared Bat	V	V	Only known from three cave systems, all south of Bundaberg. The survey area lies well outside the known distribution of the species.	U	U
Mammal	*Pteropus poliocephalus*	Grey-headed Flying-fox	V	LC	Rainforests and wet eucalypt forests well south and east of the survey area. No records within 100 km.	U	U
Reptile	*Elseya albagula*	Southern Snapping Turtle	CE	E	Large permanent to semi-permanent river systems. The survey area lies outside the known distribution of the species, and suitable habitat is lacking.	U	U
Reptile	*Rheodytes leukops*	Fitzroy River Turtle	V	V	Inhabits deep pools with fallen timber in rivers with fast-flowing water. Suitable habitat is absent from the survey area.	U	U
Fish	*Maccullochella peelii*	Murray Cod	V	-	Clear, rocky streams, slow-flowing or turbid lowland rivers and billabongs. The survey area lies well outside the natural range of the species.	U	U
Cycad	*Cycas ophiolitica*	Marlborough Blue Cycad	E	E	Grows on steep slopes and hill tops in coastal areas over 100 km east of the survey area.	U	U
Tree	*Cadellia pentastylis*	Ooline	V	V	Edges of sandstone or basalt escarpments within *Acacia harpophylla*, vine-thicket, poplar box and bendee vegetation communities. The survey area lies outside the known distribution of the species. A very small amount of suitable habitat for the species exists on site, and this was thoroughly surveyed.	U	U
Tree	*Samadera bidwillii*	Quassia	V	V	Occurs in lowland rainforest 120 km east of the survey area.	U	U

*Status under the *Environment Protection and Biodiversity Conservation Act 1999*: CE = critically endangered, E = endangered, V = vulnerable, M = migratory.
†Status under the *Nature Conservation Act 1992*: E = endangered, V = vulnerable, LC = least concern, SL = special least concern.
‡Presence within survey area in which the project is contained: C = presence confirmed, L = likely to be present, P = possibly present, U = unlikely to be present.
§Listed under the EPBC Act as *Petauroides volans.*

Koala

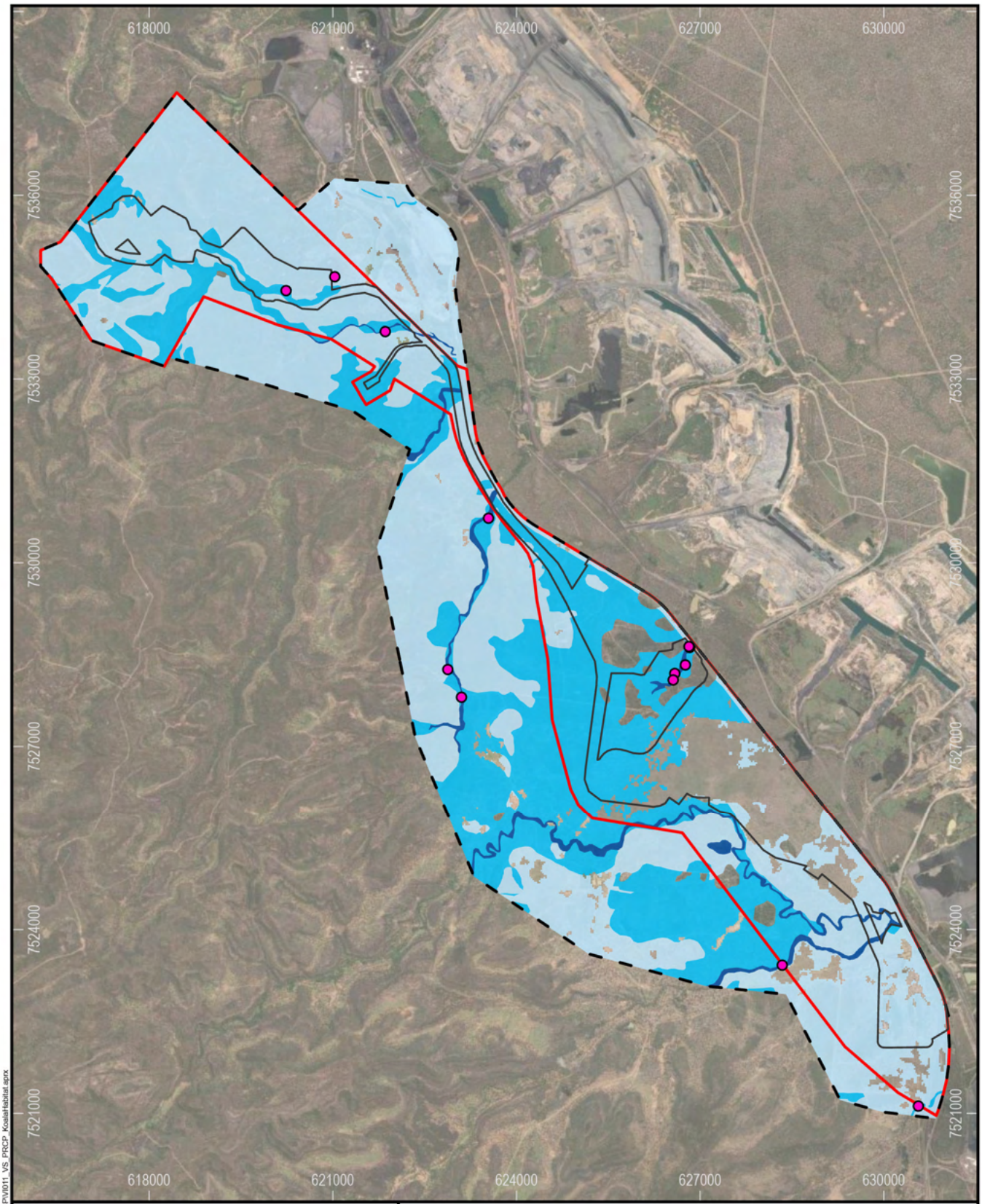
Koalas (*Phascolarctos cinereus*) within Queensland are listed as endangered under the EPBC Act and the NC Act. This species was recorded 14 times within the survey area, involving at least 12 individuals. It is highly likely that more individuals were present than were detected. The Threatened Species Scientific Committee (2012) suggests an average Koala density of 0.005 Koalas/ha across the Brigalow Belt. Assuming this same density across the survey area, 33 individuals are likely to occur within the survey area. This estimate has low reliability, given the lack of local data on population densities.

The Australian Koala Foundation (2015) maintains a database of the food trees known to be used by Koalas in each local government area of Australia. This database lists *Eucalyptus camaldulensis* and *Eucalyptus tereticornis* as the primary food trees in the Isaac Regional Council area. Secondary food trees include *Eucalyptus brownii*, *Eucalyptus coolabah*, *Eucalyptus ochrophloia*, *Eucalyptus orgadophila* and *Eucalyptus populnea*. Of these species, *E. camaldulensis*, *E. orgadophila* and *E. populnea* are found within the survey area (**Table 1-5)**. *Eucalyptus crebra* can sometimes constitute an additional secondary food species in localised areas with better soil and nutrient availability, and is eaten by Koalas at nearby sites (Ellis *et al.* 2002; Melzer *et al.* 2014). The distribution of these habitats across the Project is shown in **Figure 1-17**. The Project area contained 78.4 ha of high-value habitat, 1,152.8 ha of moderate-value habitat and 1,937.8 ha of low-value habitat.

Table 1-5 Distribution of Koala food trees across vegetation units in the survey area

Regional Ecosystem*	Area (ha)*	Primary Food Trees	Secondary Food Trees	Overall Value to Koalas†	N_{Koalas}/100ha‡
11.3.2	276.2	Absent	*E. populnea* dominant	Moderate	0
11.3.7	86.4	*E. camaldulensis* occasionally present	*E. populnea* and/or *E. crebra* sometimes subdominant	Moderate	0
11.3.25	153.0	*E. camaldulensis* dominant	*E. populnea* and/or *E. crebra* sometimes subdominant	High	7.19
11.3.27e	6.5	*E. camaldulensis* dominant	*E. populnea* and/or *E. crebra* sometimes subdominant	High	0
11.4.8	131.4	Absent	Absent	Nil	0
11.4.9	16.2	Absent	Absent	Nil	0
11.5.3	517.6	Absent	*E. populnea* dominant	Moderate	0
11.5.9	1,152.5	Absent	*E. crebra* sometimes dominant, but some variants of this RE lack secondary food trees.	Moderate	0
11.9.2	326.4	Absent	*E. orgadophila* dominant	Moderate	0
11.10.1	265.9	Absent	*E. crebra* usually subdominant	Moderate	0.38

11.10.1x1	412.3	Absent	*E. crebra* occasionally present in low densities	Low	0
11.10.3	1,642.1	Absent	*E. crebra* occasionally present as a scattered emergent	Low	0.06
11.10.7	341.6	Absent	*E. crebra* dominant	Moderate	0.29
11.10.8	1.3	Absent	Absent	Nil	0



Legend

- Koala Sighting
- Survey Area
- MLA Area
- Maximum Disturbance Footprint

Koala Habitat

- High Quality
- Moderate Quality
- Low Quality

Source: Australian Government (Department of Industry, Science, Energy and Resources) 2021, METServe 2020-2023, Vitrinite 2022-2023, Earthstar Geographics. Koala habitat derived from the National Forest and Sparse Woody Vegetation dataset (Version 5.0) and field-verified regional ecosystem data.

Vulcan South

Koala Habitat

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-17

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_Koalahabitat.aprx

Central Greater Glider

The Greater Glider (*Petauroides volans*) is listed as an endangered species under the EPBC Act and NC Act. Recent studies have suggested that this taxon comprises three genetically distinct species, with the Central Greater Glider (*P. armillatus*) being present in the survey area (McGregor *et al.* 2020). Its taxonomy under the EPBC Act and NC Act is yet to be revised in accordance with this recent study.

Greater Gliders feed on the young leaves of *Eucalyptus* and *Corymbia*, and inhabit tall forests with abundant large hollow branches, in which they shelter during the day. Local populations are largely restricted to riparian environments, where large, hollow trees are most abundant, and subsoil moisture allows food trees to grow fresh leaves over extended periods of the year.

A total of 20 individual Central Greater Gliders were recorded across the survey area (**Figure 1-18**). With the exception of a single record in regional ecosystem 11.10.1, all of these records were in riparian environments (regional ecosystems 11.3.25, 11.3.7, 11.3.27e and regrowth 11.3.25 with many retained large trees), despite these habitats comprising only a small percentage of the survey area. This is clear evidence for the importance of riparian habitats for local populations of the Central Greater Glider. The Project area contained 328.2 ha of habitat for the Central Greater Glider.

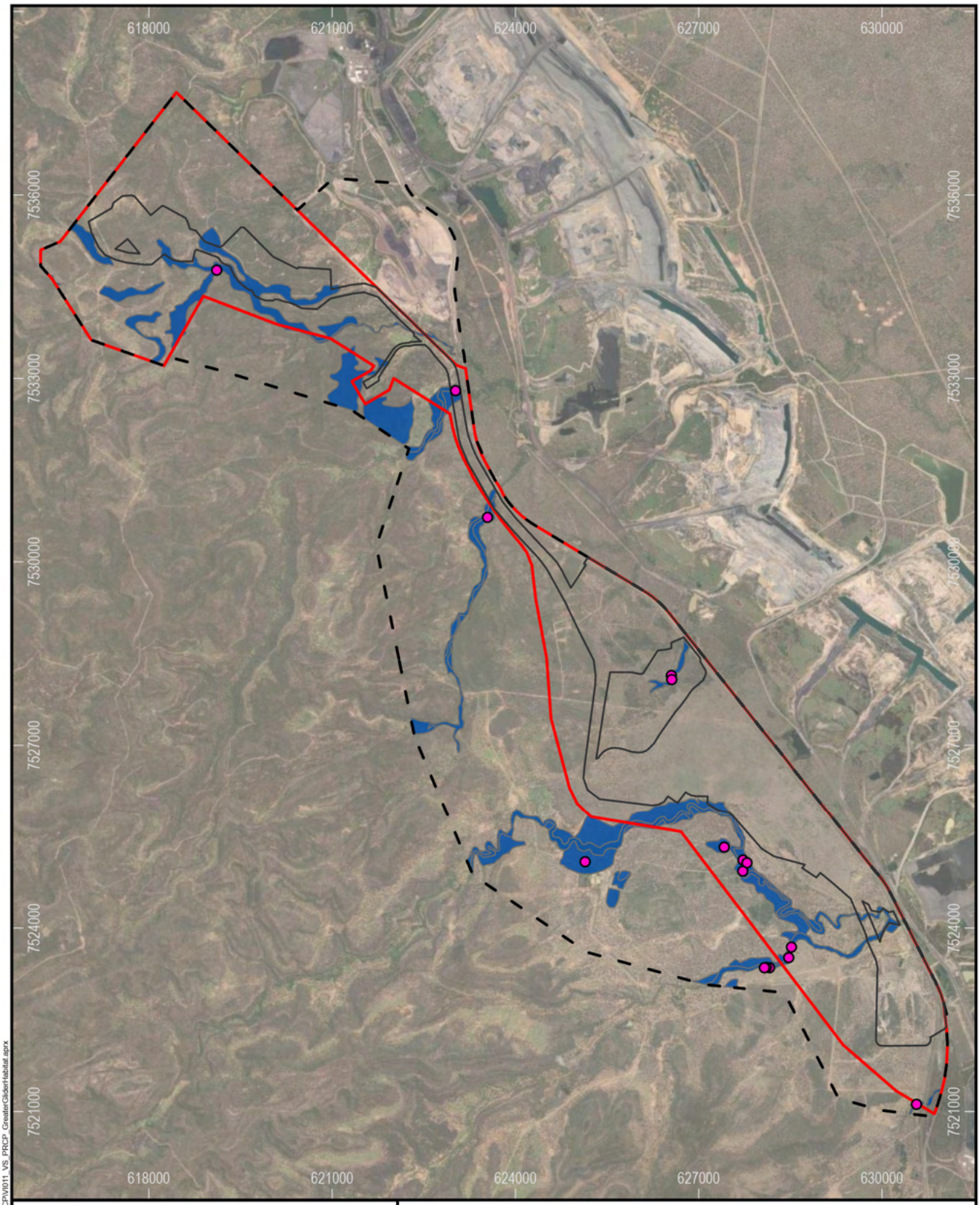
Squatter Pigeon

The southern subspecies of the Squatter Pigeon (*Geophaps scripta scripta*) is listed as vulnerable under the EPBC Act. This species was recorded on numerous occasions throughout the survey area (66 individual records at 28 locations).

Squatter Pigeons inhabit remnant and regrowth open woodland, or cleared areas with scattered trees and shrubs, on sandy or gravelly soils. Heavy clay soils with dense grass cover and rocky escarpments are largely avoided. Squatter Pigeons breed within 1 km of permanent water and forage within 3 km of water. They feed on the ground on fallen seed, and require a patchy ground cover of tussock grasses, litter and patches of bare ground for optimal foraging.

The distribution of Squatter Pigeon habitat across the area surrounding Vulcan South is shown in **Figure 1-19.** In total, 1,626.5 ha of foraging habitat (1,162.2 ha of which is also breeding habitat) and 1,989.5 ha of dispersal habitat was contained within the Project area.

Post-mining land uses that are conducive to the long-term conservation of Squatter Pigeons on rehabilitated land (e.g., native habitats or cattle grazing) are preferred. Likewise, the species' ecological needs (e.g., density of tree cover, establishment of grasses) were considered during the development of completion criteria.



Legend

- Survey Area
- MLA Area
- Maximum Disturbance Footprint
- Central Greater Glider Sighting
- Central Greater Glider Habitat

Source: Vitrinite 2022-2023, METServe 2020-2023, Earthstar Geographics.

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_GreaterGliderHabitat.aprx

Vulcan South

Central Greater Glider Habitat

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

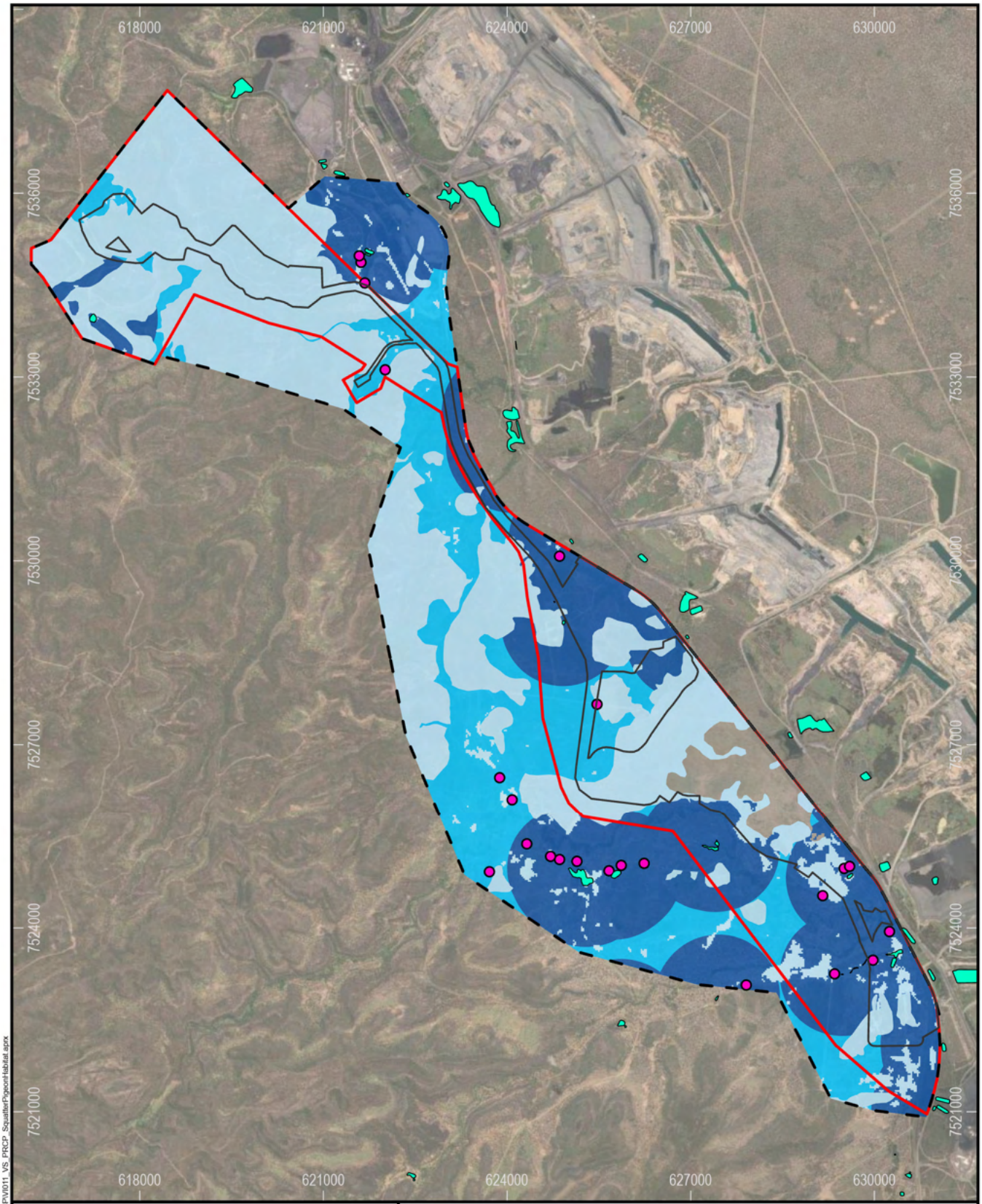
9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-18

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

- Squatter Pigeon Sightings
- Survey Area
- MLA Area
- Maximum Disturbance Footprint
- Waterbodies

Squatter Pigeon Habitat

- Breeding and foraging habitat
- Foraging habitat
- Dispersal habitat

Source: Geoscience Australia 2015, Australian Government (Department of Industry, Science, Energy and Resources) 2021, METServe 2019-2023, Earthstar Geographics. Squatter Pigeon habitat derived from the National Forest and Sparse Woody Vegetation dataset (Version 5.0) and field-verified regional ecosystem data.

Vulcan South

Squatter Pigeon Habitat

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-19

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_SquatterPigeonHabitat.aprx

White-throated Needletail

White-throated Needletails are migratory birds protected under the China-Australia Migratory Bird Agreement, Japan-Australia Migratory Bird Agreement, Republic of Korea-Australia Migratory Bird Agreement and EPBC Act. The species is also protected as a vulnerable species under the EPBC Act.

White-throated Needletails have been recorded flying over the adjacent Vulcan Coal Mine during storm activity. Vulcan South is likely to be west of their primary migration route, but flocks occasionally feed in the area when drawn west by low pressure systems. The survey area is of no particular importance to the White-throated Needletail on a local or regional scale, and the Project will not include any wind turbines, tall buildings, airports or other structures that threaten airspace used by the species for foraging and dispersal.

Ornamental Snake

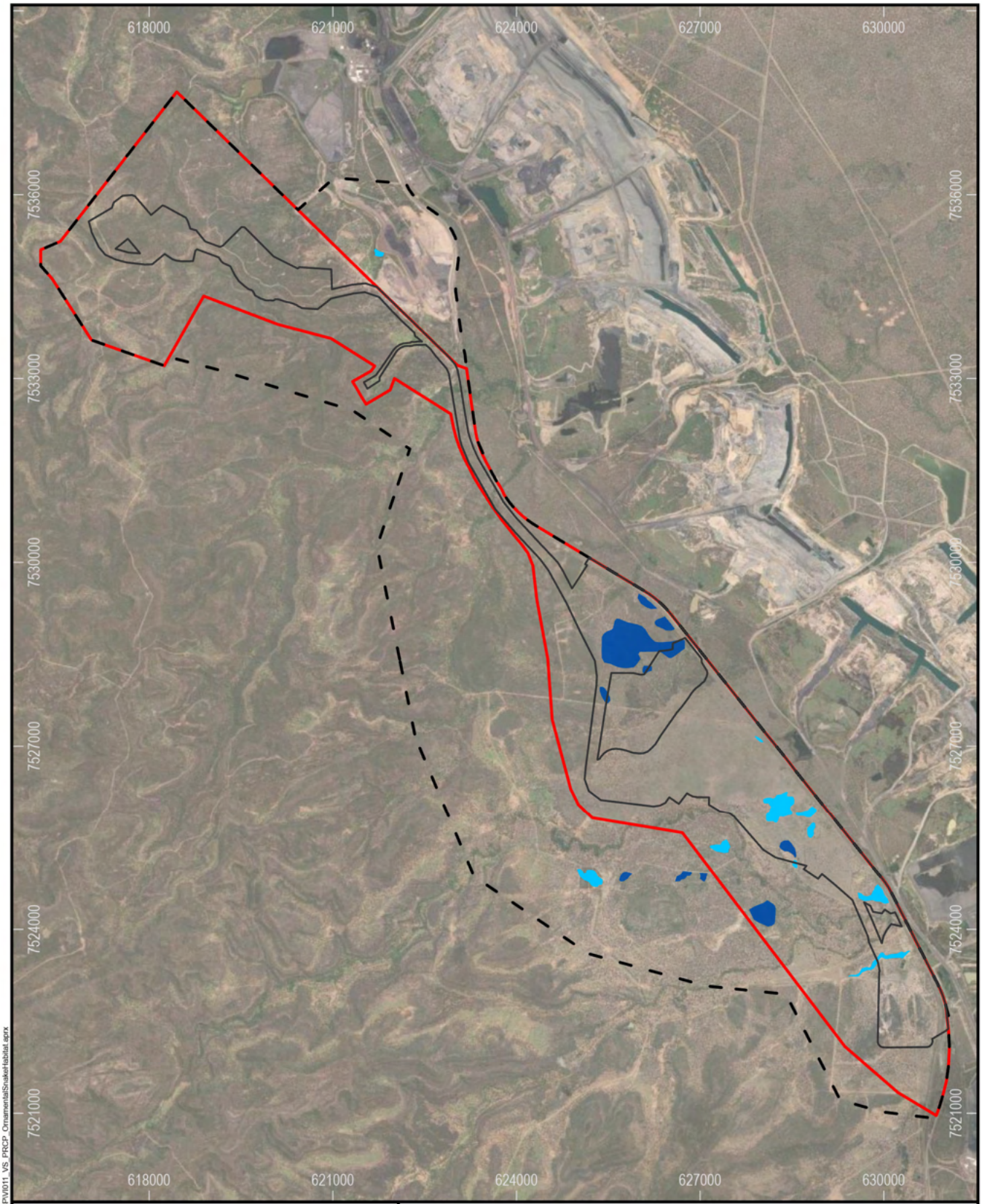
Ornamental Snakes feed on frogs and favour habitats supporting the temporary pooling of water where frogs breed. Ornamental Snakes primarily inhabit gilgai (melon-hole) mounds and depressions in deep-cracking clay plains, but also lake margins and wetlands. Locally, such habitats tend to support vegetation communities dominated by *Acacia harpophylla*. Areas with a diversity of gilgai sizes and depths provide optimal habitat. An abundance of fallen timber is also important for shelter. Cleared grasslands may also be utilised, provided that gilgais are present and some debris remains for shelter.

The Ornamental Snake occurs on the extensive clay plains at the Peak Downs Mine and Saraji Mine, immediately east of Vulcan South. Despite the proximity, favourable habitat was largely absent from the vicinity of Vulcan South. In the Project area, clay soils with *A. harpophylla* (**Figure 1-20**) contained few gilgais, and these were small, patchy and supported few frogs. Patches of *A. harpophylla* that contained gilgais, however small, and natural wetlands with aquatic vegetation were mapped as primary habitat. Dams with aquatic vegetation and cleared pasture with shallow gilgais were considered secondary habitat. No Ornamental Snakes have been located in the Project area, despite surveys coinciding with favourable weather conditions for detection. Failure to detect the species despite optimal survey conditions, combined with the poor quality of habitat present, suggests that the Project area is of marginal importance to the Ornamental Snake. For this reason, restoring habitat for the Ornamental Snake is not an objective of mine rehabilitation at Vulcan South

Australian Painted-snipe

Australian Painted-snipe are shorebirds with similar ecological requirements. This species inhabit the muddy edges of freshwater and brackish wetlands where there exists abundant low, dense vegetation for shelter. The Australian painted Snipe is a vulnerable species.

This species was recorded during ecological surveys, although it is highly mobile and behaves cryptically. This makes detection rare during surveys. Potential habitat for this species was recorded at natural and artificial (dams) wetlands in the southern third of the Project area (**Figure 1-21**).



Legend

- MLA Area
- Survey Area
- Maximum Disturbance Footprint

Potential Ornamental Snake Habitat

- Primary
- Secondary

Source: Vitrinite 2023, METServe 2020-2023, Earthstar Geographics.

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_OrnamentalSnakeHabitat.aprx

Vulcan South

Ornamental Snake Potential Habitat

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

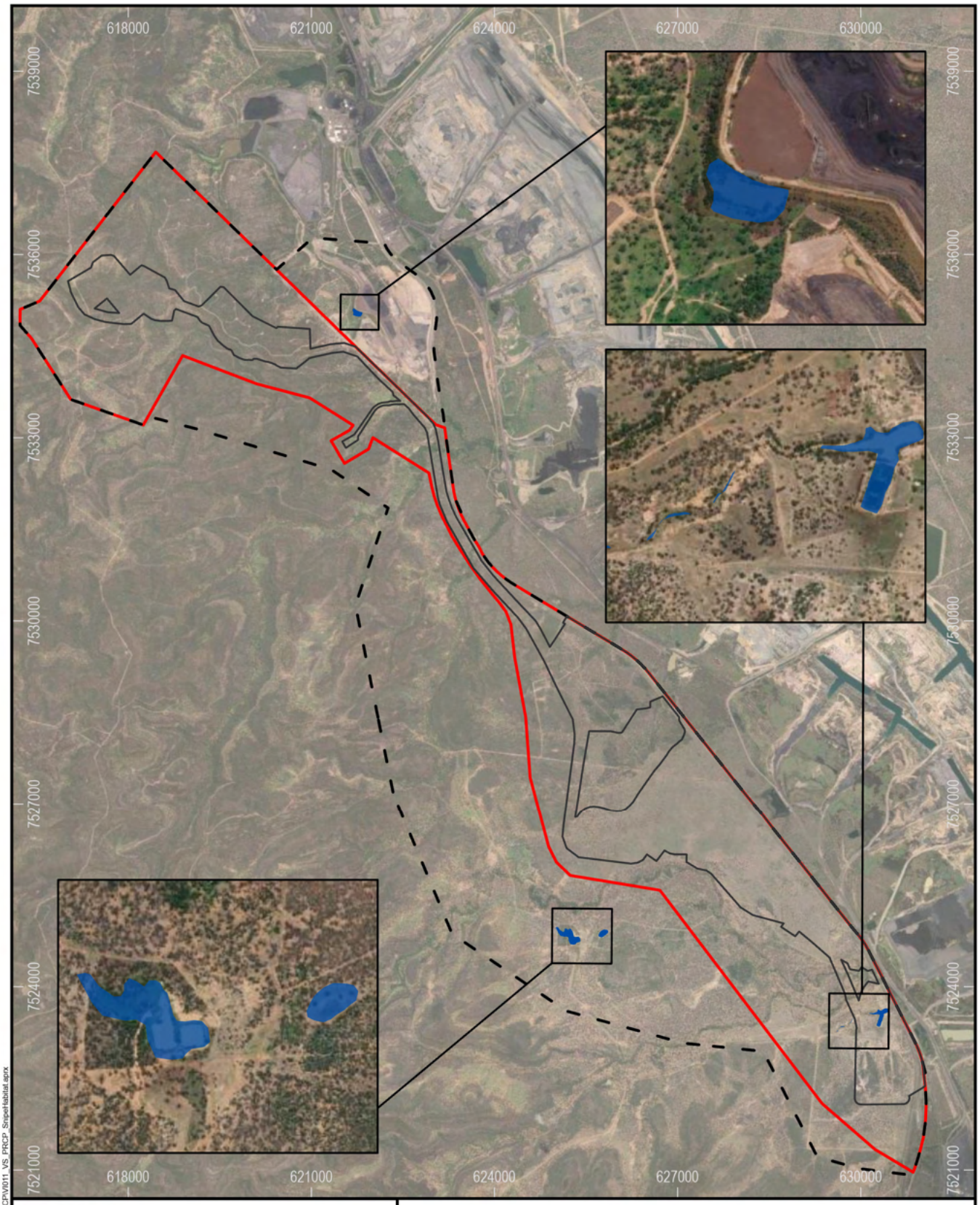
9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-20

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

- Drainage Lines
- Survey Area
- MLA Area
- Maximum Disturbance Footprint
- Potential Australian Painted-snipe Habitat

Source: Vitrinite 2022-2023, METServe 2020-2023, Maxar, Earthstar Geographics.

Vulcan South

Potential Habitat for Australian Painted-snipe

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-21

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_SnipeHabitat.aprx

Common Death Adder

The Common Death Adder is a snake that inhabits a broad range of habitats across eastern Australia. Its chief habitat requirement is abundant shelter in the form of leaf litter, woody debris and/or rocks. A low density of Cane Toads (*Rhinella marin*a) is important, as ingested toads cause lethal poisoning. Habitats well away from permanent water (where toads congregate and breed) are therefore likely to be most important for the species.

No Common Death Adders were recorded during ecological surveys. However, the species was recorded (in 2012) 25 km northeast of the Project, and it is possible that populations persist on site despite high densities of Cane Toads. Within the survey area, the sandstone ridges in the western half probably contain the most valuable habitat for the species (**Figure 1-22**). Such habitats have the highest density of shelter sites and lowest densities of toads. However, the quality of most of the existing habitat is still considered to be low. Overall, the low quality of most habitat, the small scale of disturbance to potentially important habitat corridors, and the fact that no Common Death Adders were detected despite extensive survey effort in optimal conditions, means that this species has not been considered in rehabilitation criteria (Terrestrial Ecology - **Appendix D**).

Glossy Black-Cockatoo

The Glossy Black-Cockatoo is listed as vulnerable under the NC Act. The Glossy Black-Cockatoo was not recorded on site during ecology surveys and there were no recent records (from last 50 years) within 100 km of the survey area. Desktop reviews therefore did not flag it as a species that potentially occurred in the vicinity of the Project. Nevertheless, one pair was observed during weed monitoring undertaken within the Project area in March 2022 (**Figure 1-23**).

The cockatoo subspecies found in central Queensland (*C. L. erebus*) is known to feed primarily on *Casuarina cristata, Allocasuarina torulosa* and *Allocasuarina littoralis.* Of these food trees, only *C. cristata* (Belah) occurs within the survey area, where it grows within small patches of Brigalow. The pair of Glossy Black-Cockatoos was observed feeding in one of these small groves of Belah. The site provides foraging habitat used occasionally by transient individuals, rather than a locally resident breeding population.

Red Goshawk

The Red Goshawk formerly had a wide distribution across northern and eastern Australia, occupying a variety of forested environments, but favouring the ecotone between dense forest and open woodland, especially near rivers and wetlands. In partly cleared parts of eastern Queensland it is associated with gorge and escarpment country. Within the last two decades, it has largely disappeared from the southern half of its former distribution.

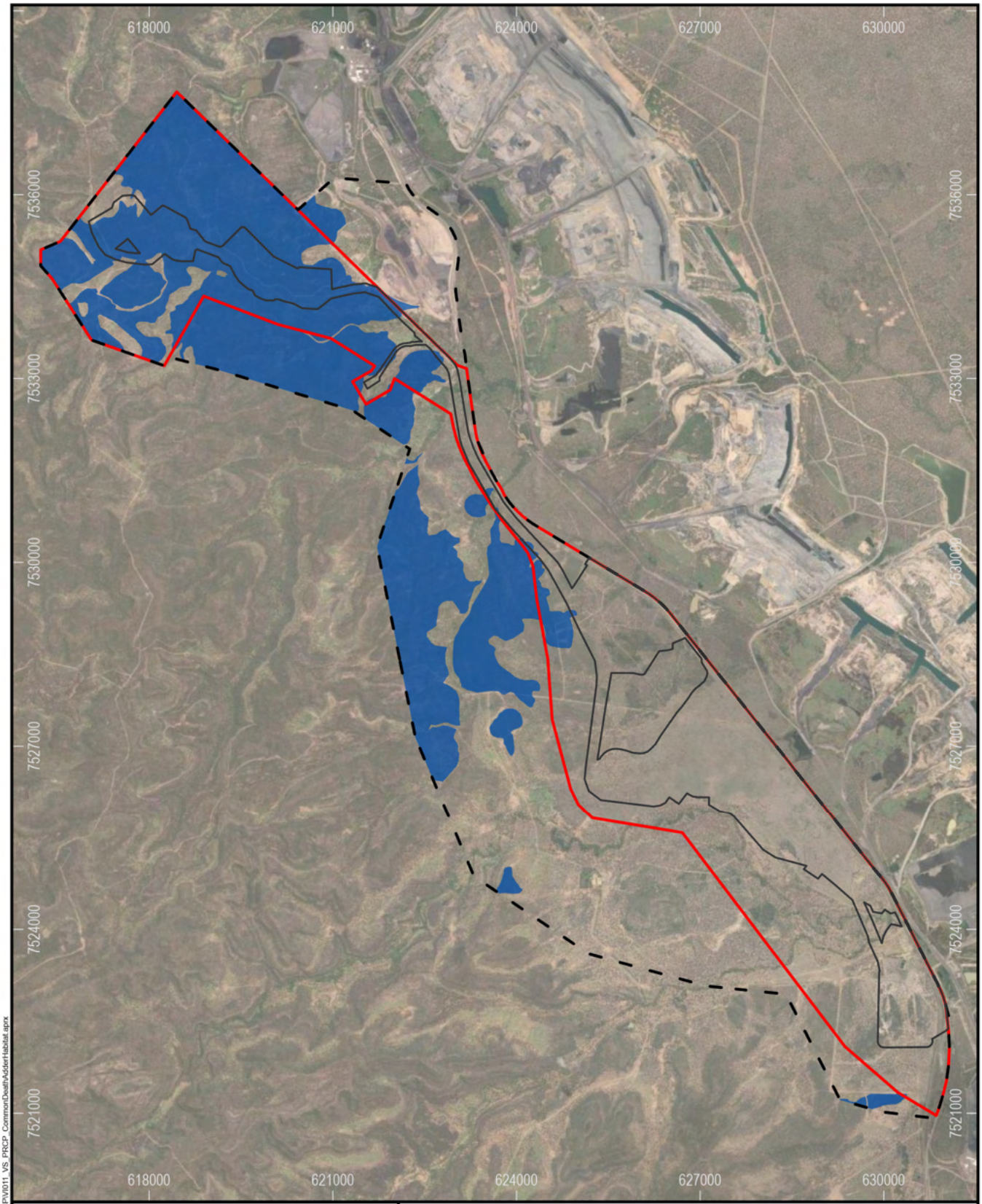
The survey area occurs within the historical distribution of the Red Goshawk. Potential habitat for the species occurs on site, although it is not of high quality; escarpments and nearby waterways mostly lack surface water, and the surrounding landscape is highly modified through mining and clearing for grazing. The Red Goshawk rarely breeds in areas with fragmented native vegetation, and never more than 1 km from water. While it is considered possible that dispersing Red Goshawks may occasionally use the survey area, the importance of the site to the species is considered to be low. Therefore, the needs of the species have not been considered specifically when designing the rehabilitation program and completion criteria at Vulcan South.

Yakka Skink

Yakka Skinks live in colonies in burrows beneath rocks, fallen timber and tree trunks. No Yakka Skinks were recorded during surveys on site. Detectability is greatest during warm, humid conditions, and surveys were under optimal conditions. Nevertheless, given the large size of the survey area, it was not practical to inspect every possible burrow location within it.

Despite numerous surveys undertaken across the northern Bowen Basin (Dysart-Moranbah-Collinsville) as part of various mining projects, Yakka Skinks have never been recorded there. The nearest record (a Queensland Museum specimen) of this species is from the vicinity of Blackwater, 130 km to the south.

Nevertheless, there are scattered records of Yakka Skinks as far north as Cape York, and there remains a slight possibility that the species occurs within the Project area. If the species is present, any remnant or regrowth habitat could be occupied. Given the low likelihood of occurrence, the ecological needs of the Yakka Skink have not been considered specifically when designing the rehabilitation program and completion criteria at Vulcan South. Nevertheless, by selecting post-mining land uses that support tree cover, potential habitat for the species is likely to be introduced to mined areas.



Legend

- Survey Area
- MLA Area
- Maximum Disturbance Footprint
- Potential Common Death Adder Habitat

Source: Vitrinite 2023, METServe 2020-2023, Earthstar Geographics.

Vulcan South

Potential Common Death Adder Habitat

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

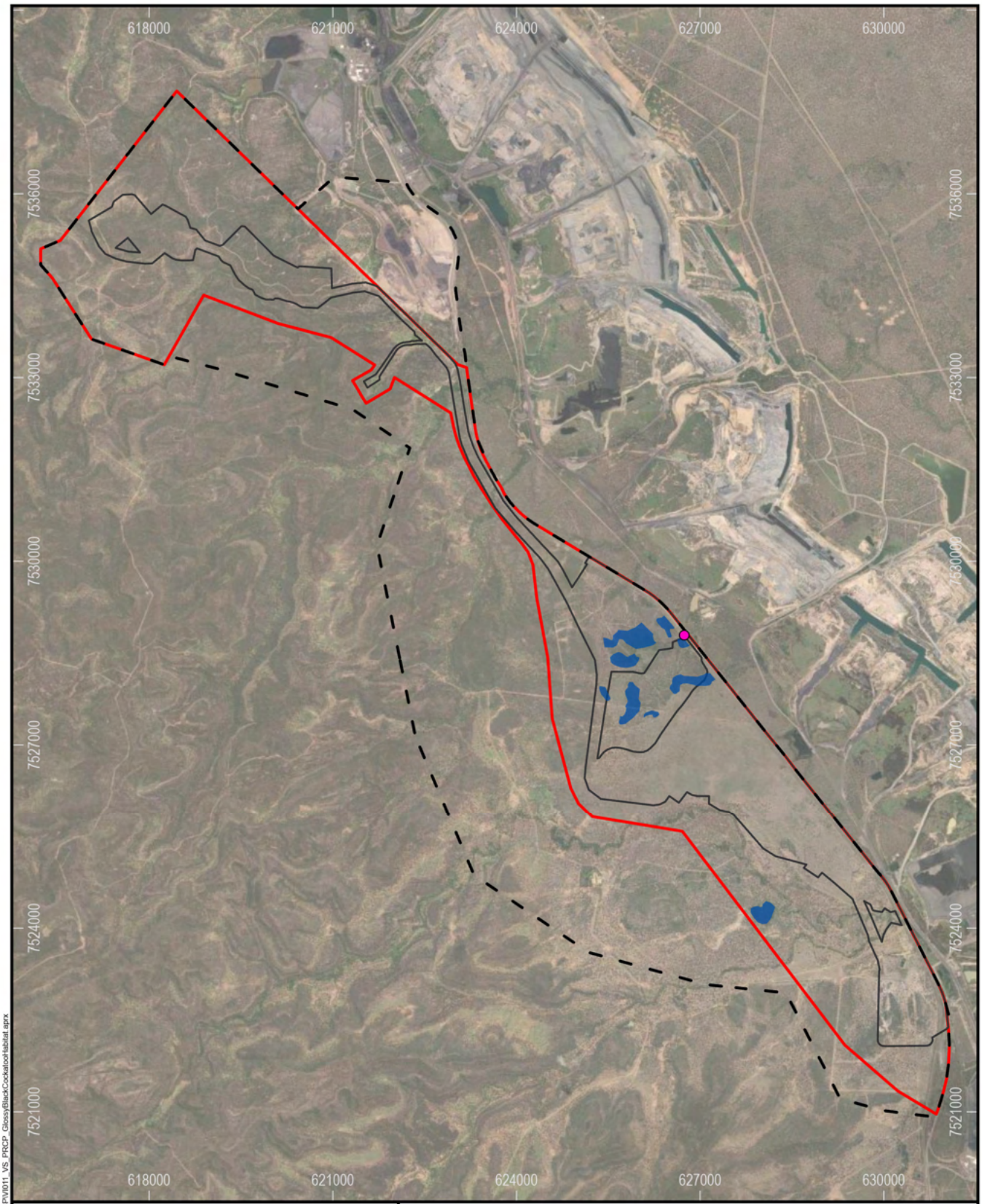
Datum: GDA2020
Projection: MGA55

FIGURE 1-22

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_CommonDeathAdderHabitat.aprx



Legend

- Glossy Black-Cockatoo Sighting
- Survey Area
- MLA Area
- Maximum Disturbance Footprint
- Glossy Black-Cockatoo Habitat

Source: Vitrinite 2022-2023, METServe 2020-2023, Earthstar Geographics.

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_GlossyBlackCockatoo\Habitat.aprx

Vulcan South

Glossy Black-Cockatoo Habitat

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-23

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Annual Wiregrass

Annual Wiregrass inhabits black clay soils, primarily those derived from basalt. It usually grows in native grasslands or open, grassy woodlands dominated by *Eucalyptus orgadophila, Eucalyptus crebra* or *Eucalyptus melanophloia.* No Annual Wiregrass was recorded during flora surveys, despite these surveys coinciding with ideal seasons for detection. No basalt-derived soil occurs on site, but black clay soils derived from sedimentary rock are present in the central part of the Project area. These areas were heavily degraded by grazing and were dominated by the exotic pasture grass, *Bothriochloa pertusa.* No areas dominated by native grasses were observed on clay soil.

The survey area lies outside the known distribution of Annual Wiregrass; however, the nearest record is only 35 km southwest. Given that potential habitat for this threatened grass exists within the survey area, its occurrence on site is considered possible. However, based on the highly degraded nature of the habitat present, the survey area is likely to be of negligible importance to the species. The needs of the species were therefore not considered during rehabilitation planning.

Ghost Bat

Ghost Bats are large, carnivorous bats whose distribution is primarily limited by suitable roost sites. Ghost bats roost and breed in caves with a small entrance hole and a large chamber, where conditions remain warm and humid year-round. Roost sites are often 30-50 m deep within the cave, where conditions are most stable.

The survey area is well outside the known winter dispersal and foraging zones of the two known central Queensland populations of Ghost Bats. However, given that the existence of unknown breeding sites is possible, and the proliferation of mining across the Bowen Basin may have inadvertently created new roosting habitats (in disused mines), it is considered possible that the survey area may be used intermittently by Ghost Bats. This use would solely be in a foraging capacity, as none of the sandstone ridges on site supported caves of a size and structure suitable as a roost site. No Ghost Bats were recorded during surveys, and the needs of the species were not considered during rehabilitation planning.

Dunmall's Snake

The Dunmall's Snake is poorly known and rarely recorded. The species inhabits a variety of wooded habitats, ranging from *Acacia harpophylla* on cracking clay soil to *Eucalyptus citriodora*, *Eucalyptus crebra* and *Eucalyptus melanophloia* open forest on sandstone-derived soil.

Despite containing potential habitat for the species, the survey area lies outside the known/likely distribution of the Dunmall's Snake. It is, therefore, not considered "important habitat" for the species. Nevertheless, the survey area lies within the modelled "may occur" zone, and given the difficulty associated with detecting this highly cryptic species, its presence on site is considered possible. No Dunmall's Snakes were detected during surveys. The nearest record is from Clermont, 80 km southwest of the survey area. The needs of the species were not considered during rehabilitation planning.

Allan's Lerista

Allan's Lerista is a skink that is confined to black soil downs (undulating plains formed primarily on basalt) in the vicinity of Clermont. It burrows within the upper profile of heavy clay soil under tussocks of grass. It is typically recorded from *Eucalyptus orgadophila* and *Corymbia erythrophloia* open woodlands.

No Allan's Leristas were found during surveys. The nearest known population to the survey area is 30 km west. However, it is separated from the survey area by a 130-km long sandstone ridge, which likely constitutes an important barrier to dispersal. The species has never been recorded east of this ridge.

Suitable habitat for the species is defined as being regional ecosystems 11.8.5 and 11.8.11, both of which are lacking from the Project area. Nevertheless, regional ecosystem 11.9.2 (*E. orgadophila* open woodland on soil derived from fine-grained sedimentary rock) occurs on site, and closely resembles 11.8.5 in its floristics and soil attributes. Furthermore, models indicate that the species may occur within the survey area, despite the site being outside the modelled "known/likely to occur" zone.

Taken together, it remains possible that the Allan's Lerista occurs within the survey area, but based on current understanding the survey area does not contain important habitat for the species. For this reason, the species was not considered during rehabilitation planning.

King Blue-grass

King Blue-grass inhabits native grasslands and open woodlands on black cracking clay soil derived from basalt. The species also colonises pastures established following the clearance of *Acacia harpophylla* and other dense vegetation communities growing on heavy clay soil. King Blue-grass cannot tolerate continual heavy stocking regimes, and is outcompeted by exotic grass species and weeds, which tend to dominate heavily grazed pastures. For this reason, most extant populations are confined to road reserves and other sites semi-protected from grazing livestock.

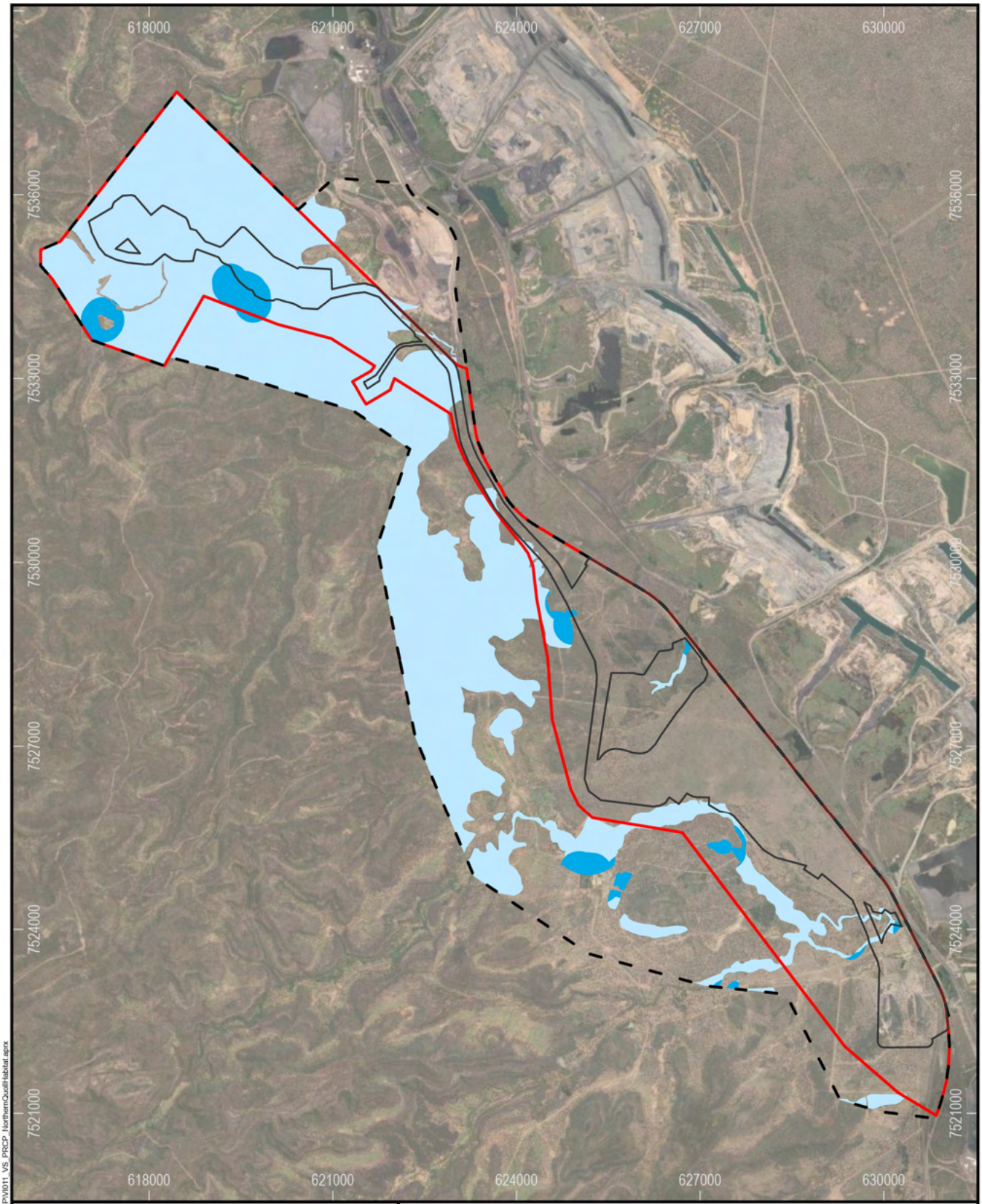
Heavy clay soils supporting grasses are represented within the survey area by remnant regional ecosystem 11.9.2 and cleared pastures that formerly supported regional ecosystem 11.4.9. Both habitats have been subjected to long periods of heavy grazing. This has led to the almost complete replacement of native perennial grasses with the exotic *Bothriochloa pertusa.* Road verges protected from grazing livestock were dominated by other weed grasses, such as *Cenchrus ciliaris, Megathyrsus maximus, Chloris* spp. and *Hyparrhenia rufa*. Nowhere within the survey area were clay soils observed to support a native grassland community.

The nearest recorded King Blue-grass is in the vicinity of Moranbah Airport, 30 km north of the survey area. While the species possibly once inhabited the survey area, its continued existence is unlikely considering current grazing regimes. The needs of the species were therefore not considered during rehabilitation planning.

Northern Quoll

Important habitat for the Northern Quoll is located in "rocky habitats, treed creek lines and structurally diverse forest with large trees, termite mounds and hollow logs" (Department of the Environment 2016), which is locally restricted to the Harrow Range and major watercourses (**Figure 1-24**)

It is unknown whether any of the potential habitat for Northern Quolls is occupied by the species. Extensive survey efforts, in optimal conditions, failed to detect one. There are also no records of the species west of the Clarke Range or Redcliffe Plateau in the past 40 years. It is therefore most likely that the Northern Quoll is absent from the vicinity of Vulcan South. In the unlikely event that the species does occur on site, the vicinity of the highwall mining trial, and other parts of the Harrow Range, contains sandstone outcrops and gorges that potentially harbour den sites for the species. Overall, it is considered unlikely that the Northern Quoll occurs at Vulcan South, and the species was not considered in rehabilitation planning.



Legend

- Survey Area
- MLA Area
- Maximum Disturbance Footprint

Potential Northern Quoll Habitat

- Habitat Within 300m of Water
- Landzone 3 and 10

Source: Vitrinite 2023, METServe 2020-2023, Earthstar Geographics.

Vulcan South

Potential Northern Quoll Habitat

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-24

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_NorthernQuollHabitat.aprx

1.2.11 Pre-mining land use

The land within the Project is zoned as Rural under the Isaac Regional Council Planning Scheme. It is currently primarily used for low-intensity cattle grazing.

Forty-two percent of the proposed Project footprint had been previously cleared of its natural vegetation; the remaining 58% comprises native remnant vegetation with an understorey that has been highly modified by grazing (see **Section 1.2.9**). The dominant land use adjacent to the Project (to the north and east) is coal mining.

The land has an agriculture land class of C2 (land suitable for grazing on native pastures on lower fertility soils) or C3 (land suitable for light grazing on native pastures in accessible areas, and includes steep land), in accordance with the *Guidelines for Agricultural Land Evaluation in Queensland* (DSITI and DNRM 2015).

The Project does not contain areas of regional interest (priority living areas, priority agricultural areas, strategic cropping land and strategic environmental areas) protected under the *Regional Planning Interests Act 2014.*

The project location also contains Saraji Road and an existing rail corridor to the east.

Based on the pre-mining land use and the results of the soil and land suitability assessment, it is anticipated that most rehabilitated landforms will be able to support a post-mining land use of cattle grazing (AARC, 2022).

For the purposes of this PRC Plan, the pre-mining land uses are:

- low-intensity cattle grazing;
- native ecosystems;
- public road; and
- rail.

Land Suitability Ratings

An assessment of land suitability for cattle grazing was undertaken in accordance with the *Guidelines for Agriculture Land Evaluation in Queensland* (DSITI and DNRM 2015) and *Technical Guidelines for the Environmental Management of Exploration and Mining in Queensland - Land Suitability Assessment Techniques* (DME, 1995). This assessment considered water availability, nutrient deficiency, soil physical factors, salinity, rockiness, microrelief, pH, exchangeable sodium percentage, wetness, water erosion, flooding and vegetation regrowth. The results of this assessment are summarised for the Project area in **Table 1-6**, , **Figure 1-25** and **Figure 1-26**. Land suitability class by soil management unit (SMU) (**Section 1.2.7**) is presented in **Table 1-7** for rain-fed broadacre cropping and **Table 1-8** for grazing. None of the land assessed in the Project area, or the encompassing study area attained a land suitability score better than Class 3 for either of the considered land uses of rain-fed broadacre cropping or grazing.

Table 1-6 Pre-mining Land Suitability Classes (Vulcan South MLA)

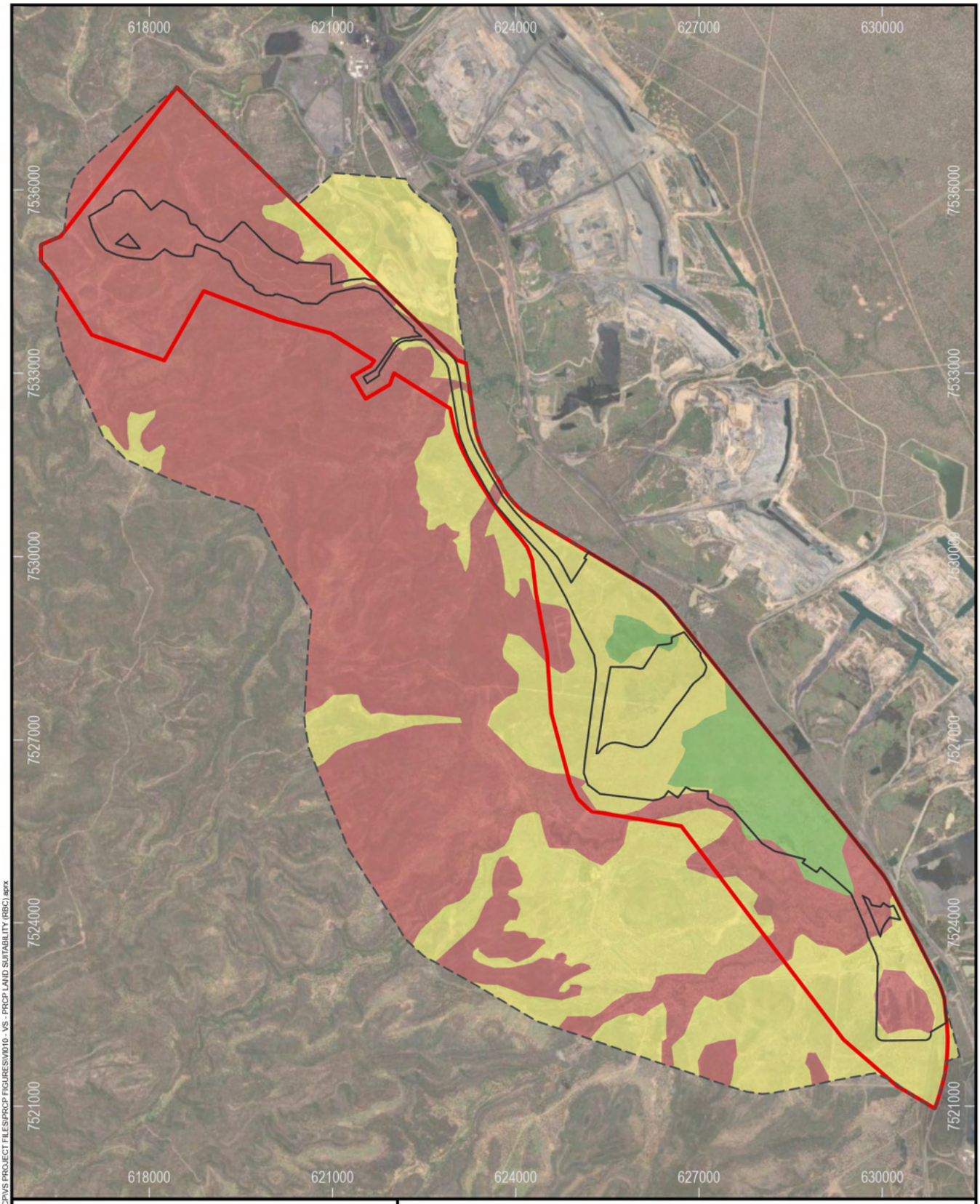
Land Use	**Class 1** Suitable land with negligible limitations	**Class 2** Suitable land with minor limitations	**Class 3** Suitable land with moderate limitations	**Class 4** Marginal land	**Class 5** Unsuitable land
Rain-fed Broadacre Cropping	0%	0%	5%	37%	58%
Grazing	0%	0%	7%	68%	25%

Table 1-7 Pre-mining Rain-fed Broadacre Cropping Landuse Suitability Classes by SMU

Limitation	Crocodile	Fish	Kei	Komati	Limpopo	Orange	Sabie	Zambezi
Water availability	5	5	4	3	4	3	4	5
Nutrient deficiency	3	4	4	4	4	3	5	4
Soil physical factors	3	1	1	2	1	2	3	1
Soil workability	2	1	1	2	1	2	1	1
Salinity	1	1	1	3	1	3	1	1
Rockiness	3	1	1	1	1	1	1	1
Microrelief	1	1	1	2	1	2	1	1
Wetness	1	3	2	3	2	3	2	3
Topography	4	1	1	1	1	1	2	2
Water Erosion	5	2	2	1	2	1	2	2
Flooding	1	1	1	2	1	2	1	3
Overall Suitability Class	**5**	**5**	**4**	**4**	**4**	**3**	**5**	**5**

Table 1-8 Pre-mining Grazing Landuse Suitability Classes by SMU

Limitation	Crocodile	Fish	Kei	Komati	Limpopo	Orange	Sabie	Zambezi
Water availability	5	4	3	2	3	3	3	4
Nutrient deficiency	4	4	4	3	4	4	4	4
Soil physical factors	1	1	1	2	1	1	3	1
Salinity	1	1	1	3	1	1	1	1
Rockiness	3	1	1	1	1	1	1	1
Microrelief	1	1	1	1	1	1	1	1
pH	2	2	2	2	2	2	3	2
ESP	1	2	1	1	1	1	1	1
Wetness	1	2	2	2	2	2	1	2
Water erosion	2	1	1	1	1	1	1	1
Flooding	1	1	1	2	1	1	1	2
Vegetation Regrowth	1	1	1	2	2	2	1	2
Overall Suitability Class	**5**	**4**	**4**	**3**	**4**	**4**	**4**	**4**



Legend

- MLA Boundary
- Maximum Disturbance Footprint
- Survey Boundary

Land Suitability (Rainfed Broadacre Cropping)

- Class 3
- Class 4
- Class 5

Source: AARC Environmental Solutions 2019, Vitrinite 2022-2023, METServe 2022-2023, Earthstar Geographics.

Vulcan South

Land Suitability Classes for Rainfed Broadacre Cropping

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

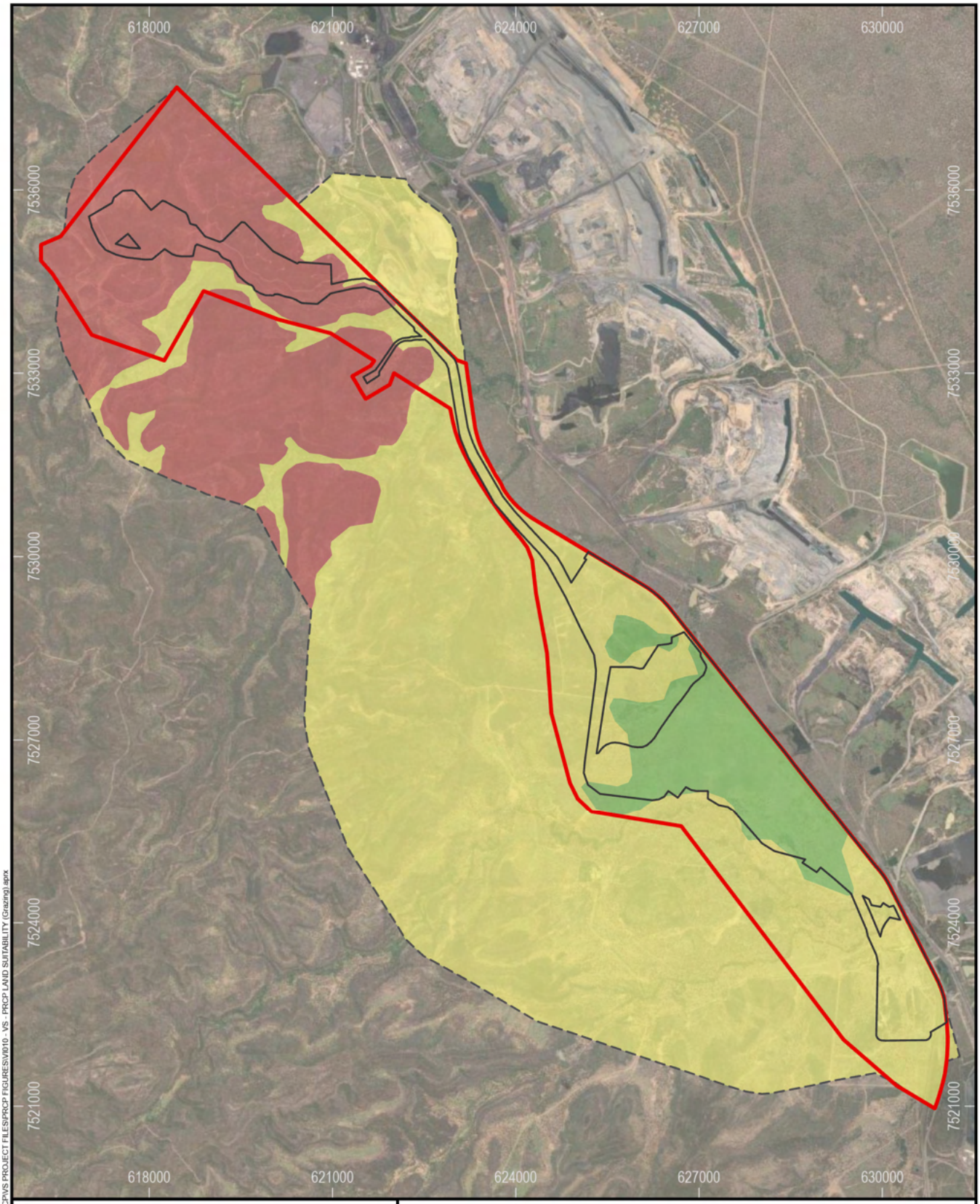
Datum: GDA2020
Projection: MGA55

FIGURE 1-25

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011 VCP Stage2\ArcGIS\ProjectFiles\Projects\PRCP\VS PROJECT FILES\PROP FIGURES\V6010 - VS - PRCP LAND SUITABILITY (RBC).aprx



Legend

- MLA Boundary
- Maximum Disturbance Footprint
- Survey Boundary

Land Suitability Class (Grazing)

- Class 3
- Class 4
- Class 5

Source: AARC Environmental Solutions 2019, Vitrinite 2022-2023, METServe 2022-2023, Earthstar Geographics.

Vulcan South

Land Suitability Classes for Grazing

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-26

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011 VCP Stage2\ArcGIS\ProjectFiles\Projects\PRCP\VS PROJECT FILES\PRCP FIGURES\V6010 - VS - PRCP LAND SUITABILITY (Grazing).aprx

1.2.12 Land Holders

Land Holders

A list of the properties, tenure, usage and owners/managers within the proposed ML boundary are provided in **Table 1-9**.

Table 1-9 Land Tenure and Real Property Descriptions for Vulcan South

Lot/Plan	Tenure	Usage	Owner
2/SP296877	Lands Lease	Pastoral	O'Sullivan
59/SP235297	Lands Lease	Pastoral	O'Sullivan
72/SP137467	Reserve	Railway	Aurizon
Saraji Road	Road Licence	Road for public use	Isaac Regional Council
26/CNS125	Lands Lease	Norwich Park Branch Railway	Aurizon
2/CNS109	Lands Lease	Norwich Park Branch Railway	Aurizon
3/CNS109	Lands Lease	Saraji Mine Balloon Loop Railway	Aurizon

1.3 Relevant Activities

1.3.1 Environmentally Relevant Activities

An Environmental Authority (EA) application for the Project has been submitted primarily for Environmentally Relevant Activity (ERA) 13: Mining black coal (as per schedule 3, column 1 of the EP Regulation). Ancillary ERAs listed under schedule 2 of the EP Regulation will also be required. ERAs for the Project are listed in **Table 1-10**

Table 1-10 Environmentally Relevant Activities Requiring Approval

Activity	Environmentally Relevant Activity	Project Requirement
Mining black coal	ERA 13	The Project will extract up to 13.5 Mt of coal through an open cut operation
Crushing, milling, grinding or screening	ERA 33 Crushing, grinding, milling or screening more than 5,000 t of material in a year	The Project will crush and screen up to 1.95 Mtpa of ROM coal

1.3.2 Project Description

The Vulcan South hard coking coal target will be extracted via three separate open-cut pits, which form the primary mining focus of the Project. The Project will operate for approximately seven years, including primary rehabilitation works, following a two-year construction period and will extract approximately 13.5 Mt of Run of Mine (ROM) coal consisting predominately of hard coking coal with an incidental thermal secondary product at a rate of up to 1.95 Mtpa.

The Project will target the Alex and multiple Dysart Lower coal seams. A mine infrastructure area (MIA) will be established along with a modular coal handling and preparation plant (CHPP), rail loop and train load-out facility (TLO) at a location between the northern and central pits. The CHPP will include solid bowl centrifuges to maximise water recycling and to produce a dry tailings waste product for permanent storage within waste rock dumps.

Ex-pit waste rock dumps will be established prior to commencing in-pit dumping activities that will continue for the life of the operation. Ancillary infrastructure, including a ROM pad, offices, roads and surface water management infrastructure will be established to support the operation.

A realignment of the existing Saraji Road and services infrastructure to the eastern boundary of the proposed Mining Lease Application (MLA) area, adjacent to the existing rail easement, is also proposed in a number of locations. The re-alignment will occur within the MLA area.

In-pit dumping will fill the majority of the pits during operations, with the remaining voids to be backfilled upon cessation of mining, resulting in the establishment of waste rock dump landforms over the former pit areas. Following backfill of the final voids, the remaining material stored in the initial ex-pit waste rock dumps will be rehabilitated in-situ.

The Project includes a small-scale highwall mining trial program in the north of the MLA area. The trial will involve the establishment of four highwall mining benches across a number of hillsides to facilitate extraction of coal utilising a CAT HW300 highwall miner. The highwall mining trial will target up to 750 kt of coal which will be transported by truck to the CHPP via a dedicated haul road within the MLA area. The trial is scheduled to be completed within the first year of mining operations.

The Project is a small-scale mining operation, with coal extraction planned for approximately seven years, followed by completion of primary rehabilitation activities in year nine. Construction of infrastructure associated with the mining operation, including the CHPP and the rail loop, is expected to be completed within two years. Construction of the realigned Saraji Road sections will be completed progressively as the pits advance towards the location of the existing road. Ongoing establishment of internal road networks, surface water management infrastructure and other ancillary infrastructure will continue to be developed as the pits and in-pit dumps advance. The Project site layout plan is displayed in **Figure 1-27**.

Open Cut Mining Activities

The maximum depth across the three pits is no deeper than approximately 60m , following the seams as they dip eastwards. The footprints of the proposed open cut pits are provided in **Table 1-11**. Truck-and-shovel mining methods will be employed to extract waste rock and coal.

Table 1-11 Open cut pit characteristics

Open Cut Pit Name	Approximate Footprint (ha)	Mining Direction	Target Seams
Vulcan North	66	North to south	Alex and multiple Dysart Lower
Vulcan Main	334	North to south	Alex and multiple Dysart Lower
Vulcan South	77	North to south	Alex and multiple Dysart Lower

Blasting

Blasting is expected to be required to access resources below unweathered rock. Approximately 24 blasts per year are expected. Blasts would be planned and scheduled to manage potential impacts on Saraji Road and nearby infrastructure and landholders.

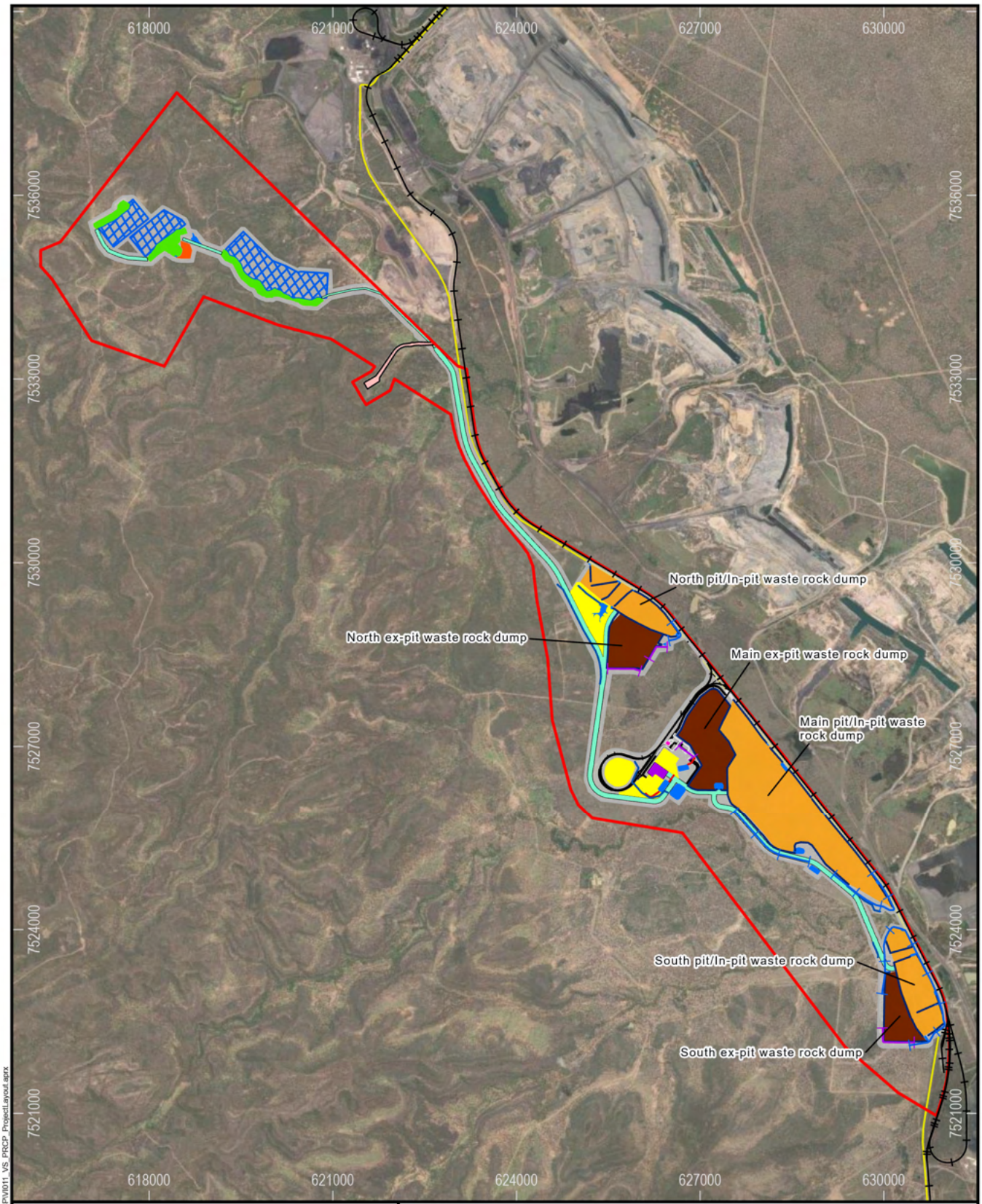
Waste rock removal and placement

Waste rock extracted during the early stages of each open pit will be placed in ex-pit dumps to the west of the open pits. Following this initial ex-pit placement and once sufficient pit space has developed, in-pit placement of waste rock will commence. This will continue for the life of each pit as it is developed. The in-pit dumps will have batters shaped up to a maximum slope of 15%. A central plateau will drain to the west to minimise the requirement for significant drainage infrastructure along the eastern toe of the dump (where space is limited, due to the presence of the existing road and rail).

An assessment of waste rock geochemistry has concluded that the waste rock does not pose a significant risk of generating saline or metalliferous drainage. Therefore, no selective handling and treatment measures are proposed. Furthermore, low-permeability capping over the dump surface is considered not to be required to create a geologically stable post-mining landform.

Coal extraction

Once waste rock has been removed to expose the coal seam, coal will be extracted via truck and shovel. The coal will be hauled to the CHPP. Crushing and screening will be completed as part of the CHPP raw coal handling circuit.



Legend

- Drainage Lines
- Railway
- Road
- Mine Access Road
- Rail Loop and Mine Roads
- Flood Levee
- Diversion Bund
- Diversion Drain
- Mine Water Drain
- Surface Water Drain
- Vulcan South Maximum Disturbance
- MLA Area
- CHPP
- Magazine
- MIA
- Dam
- Office
- Haul Road
- Ex-pit Waste Rock Dump
- Open Pit/In-pit Waste Rock Dump
- Highwall Mining Bench
- Highwall Rock Dump
- Highwall Plunge

Source: State of Queensland (Department of Resources) 2021-2022, Vitrinite 2022-2023, WRM 2022, METServe 2022-2023, Earthstar Geographics.

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Vulcan South

Site Layout

0 0.75 1.5 3

Kilometers

Scale: 1:90,000 (A4)

9/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 1-27

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Pit Geometry

The geometry of the northern, central and southern open-pit highwalls has been designed to produce stable slopes while considering the underlying geology (Blackrock Mining Solutions Pty Ltd 2019). Indicative cross-sections of the proposed pit highwalls in each of the resource areas of the Project are shown in **Figure 1-28** to **Figure 1-29,** as derived from Blackrock mining geotechnical wider pre-feasibility study which included the now separate Vulcan South project area.

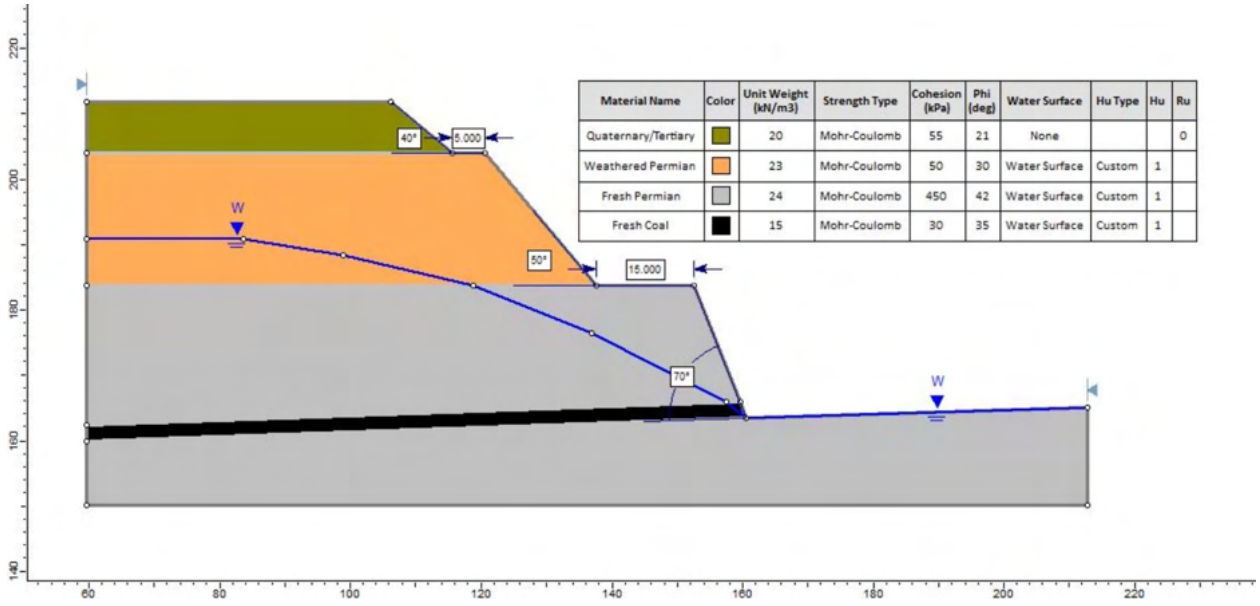


Figure 1-28 Geotechnical design of the Vulcan Central highwall (average thickness of Tertiary) (Blackrock Mining Solutions Pty Ltd 2019)

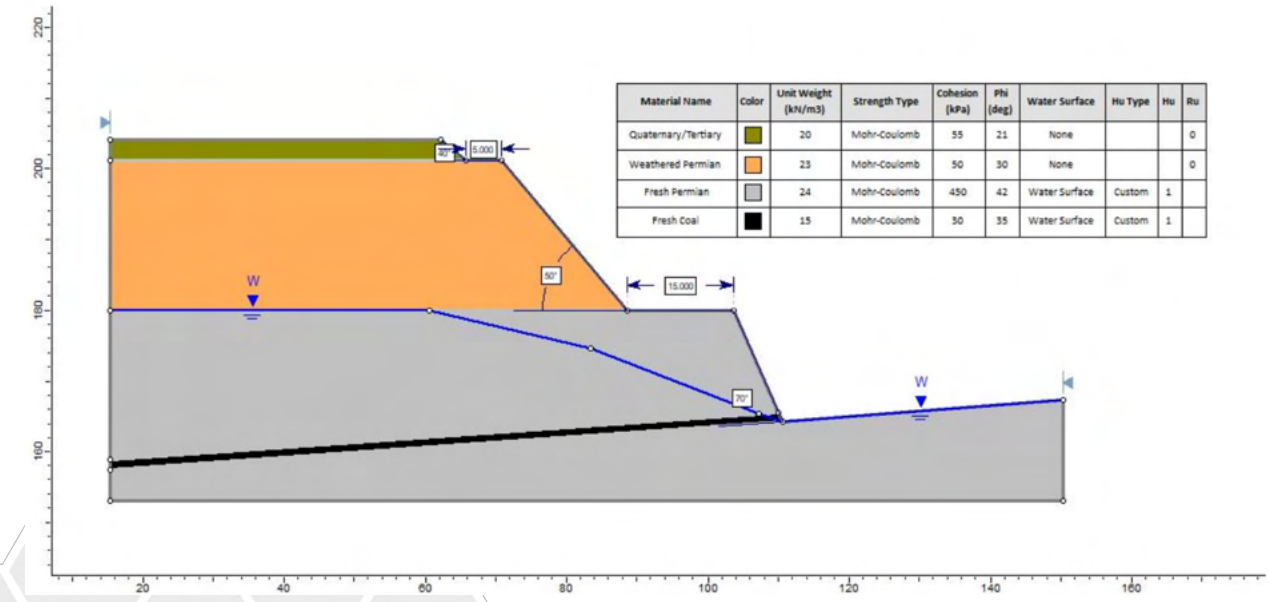


Figure 1-29 Geotechnical design of the Vulcan North/South highwalls (Blackrock Mining Solutions Pty Ltd 2019)

In-pit dumps

The most commonly used geotechnical classification of coal mine waste within the Bowen Basin is the BMA classification (Simmons and McManus 2004), as shown in **Figure 1-30**.

Most of the spoil to be generated for the Project comprises category 2. Taking into account the stability of this material, in-pit dumping will take place using benches with faces that have slopes as described in **Figure 1-31**.

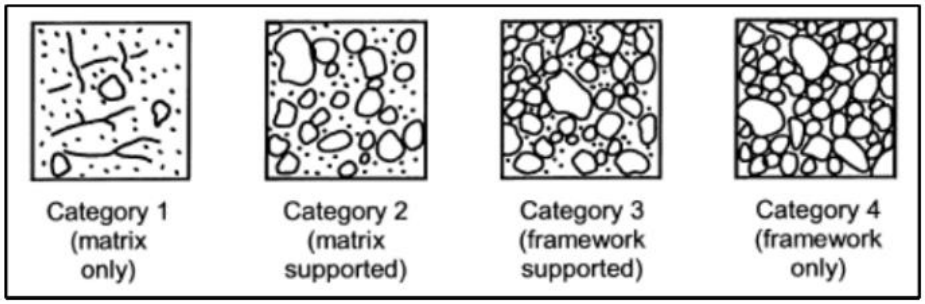


Figure 1-30 Spoil classification scheme (Simmons and McManus 2004)

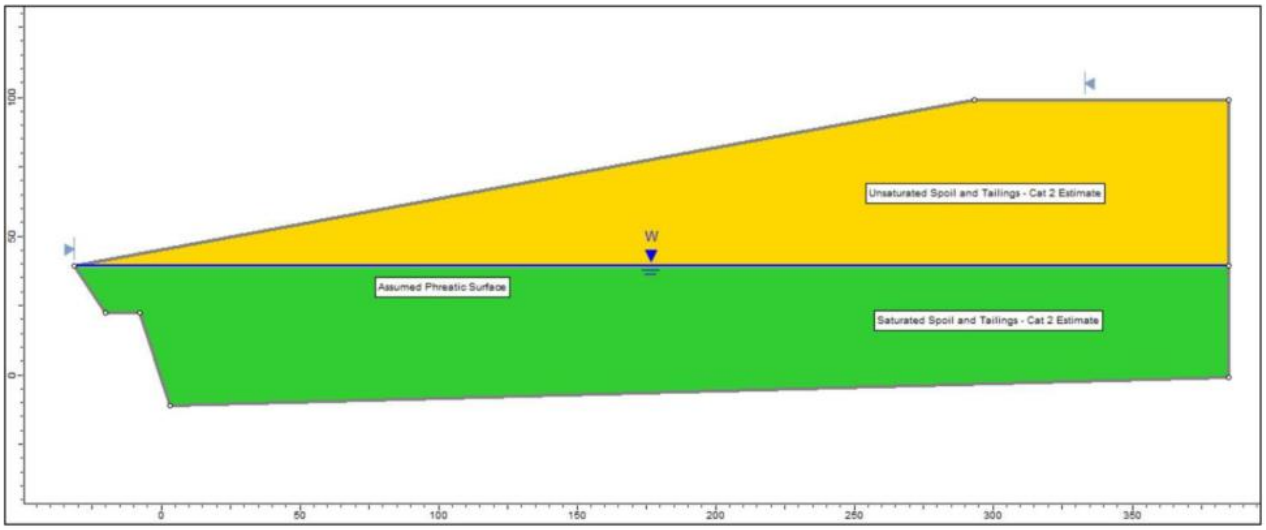


Figure 1-31 Geotechnical design of the in-pit spoil dumps of Vulcan South (Blackrock Mining Solutions Pty Ltd 2022)

Highwall Mining Trial

The Project includes a small-scale highwall mining trial program in the north of the MLA area. The trial will involve the establishment of four highwall mining benches across a series of hillsides to facilitate extraction of coal utilising a CAT HW300 highwall miner. The highwall mining trial will target up to 750 kt of coal within the first year of mining operations. Mined coal will be loaded by front-end-loader and transported by truck to the Project CHPP via a dedicated haul road within the MLA. Whilst common in other coal mining regions, the trial will test the proposed highwall mining equipment in local conditions to assist Vitrinite's decision-making on the methodology's suitability for other assets held within the region.

The target areas for the trial present competent roof and floor materials and target seams that are relatively flat . The coal seams are of a thickness that is appropriate for highwall mining (0.9 to 1.5 m) and the coal itself is of reasonable strength whilst still being easily cut with a highwall continuous miner.

The depth of cover ranges between 12 and 50 m. This is considered optimal as the underground stress regime will be low to moderate, contributing to stable immediate roof conditions and reduced pillar loads. Reduced pillar loads allow for higher extraction ratios without impacting pillar stability, increasing coal recovery. Varying pillar parameters will be tested during the trial.

Based on local cover depth, coal strength, entry width and vertical stress conditions, the proposed panel design to be used for the Project's highwall trial are as follows:

- plunge width = 3.5 m;
- web width = 1.2 m;
- barrier pillar width = 5 m;
- number of entries per barrier = 10; and
- plunge height = 1.1 m.

The above design parameters are considered conservative and exceed the recommended stability factors for the overall panel layout, web width and barrier pillar width. This conservatism is considered warranted as a starting point; however, layout optimisation is expected to occur once the trial has commenced. The above layout results in an extraction ratio of approximately 70%, with up to 2,500 t per plunge and up to 25,000 t per panel.

Minimal infrastructure will be required to support the highwall mining trial. This will include mobile diesel fuel tanks, workshop containers and portable bathroom amenities. Earthmoving equipment will be required for the development of benches for the highwall miner to operate on, as well as equipment to build and maintain the haul road to the CHPP/ROM stockpile area. The benches will form part of the haul road and will be connected by sections of linking haul road. The highwall bench is proposed to be 100 m wide, including the highwall batter and haul road.

ROM coal will be loaded from the discharge conveyor of the highwall miner onto a stacker belt for stockpiling on the active bench. Loaders will manage the stockpile and load Moxy dump trucks for haulage to the Vulcan CHPP facilities. Waste rock from the benches will be temporarily stockpiled during highwall mining activities, prior to being back-filled into the bench areas during progressive rehabilitation. One of the benches will require establishment of a small waste rock dump that will be rehabilitated in situ.

During operations, mine-affected water will be controlled through the use of diversions, sumps, bunds and placement of mine affected water into completed down-dipping highwall plunges (voids) as proposed in the Surface Water Assessment (**Appendix A**).

The key components of the mine water management strategy throughout the highwall mining stage of the Project include:

- clean water drains/contour banks and rock chutes/drop structures above the plunges will divert natural catchment runoff to the proposed surface water drains/sediment control structures and prevent contamination where active plunges are located;
- bunds along the bench will be built as required. These will direct MAW into the adjacent plunges. Bunds will also divert haul road runoff to the surface water drainage systems;
- direct mine water runoff (via gravity) either directly into a plunge or via a sump that dewaters to the plunge;
- as the highwall miner progresses, a mobile coal stockpile will keep pace within 100 m of the highwall miner before being trucked to the CHPP for processing. Disused coal stockpiles that are greater than 100 m from the highwall miner will be rehabilitated; and
- where plunges are no longer active, rehabilitation will commence to cover the voids at the surface. After covering the voids, surface runoff water would not be classified as MAW, and can be treated through the proposed sediment control structures (**Appendix A**).

Additional infrastructure

Explosive Magazine

An explosives magazine will be constructed between the highwall mining area and the Vulcan North pit, a safe distance from operational areas and critical infrastructure.

Administration buildings and warehouses

Onsite offices and administrative buildings are to be located just north of the MIA and adjacent to mine access roads for easy access.

Fuel storage and workshops

This will include mobile diesel fuel tanks, workshop containers and portable bathroom amenities. Earthmoving equipment will be required for the development of benches for the highwall miner to operate on as well as road construction and maintenance equipment to build and maintain the haul road to the CHPP/ ROM stockpile area.

ROM pad

ROM coal will be loaded from the discharge conveyor of the highwall miner onto a stacker belt for stockpiling on the active bench. Loaders will manage the stockpile and load B triple trucks for haulage to the CHPP. Waste rock from the benches will be temporarily stockpiled during highwall mining activities, prior to being back-filled into the bench areas during progressive rehabilitation. The ROM pad will be located within the MIA.

Coal handling and Processing plant (CHPP)

Coal will be processed by a modular coal CHPP. The proposed CHPP will include tailings dewatering technologies to maximise water recycling and to produce a dry tailings waste product for permanent storage within waste rock dumps. No wet tailings wastes or tailings dams are proposed.

The Project will include a modular CHPP to process ROM Coal into a number of marketable products (coking coal and thermal coal). In summary, the CHPP will include:

- A raw coal handling circuit to size ROM coal for further processing and remove incidental wastes;
- A raw coal bypass conveyor to provide the option to direct appropriate quality raw coal to the product stockpile;
- Three CHPP circuits (coarse, secondary coarse and mid-sized) for coal beneficiation, producing a single product stream;
- A tailings thickener to thicken ultrafine reject material; and
- Tailings dewatering technology to dewater tailings to a solid cake for disposal in active waste rock dumps.

The CHPP will produce dual products at any one time with different products produced in campaigns via control of different ROM feed materials. The CHPP will operate 24 hours a day, seven days per week and is anticipated to function for approximately 6 years (it may take 2 years to construct following the beginning of coal extraction until the completion of active mining). If there is an opportunity to commence the highwall trial during the VS construction period, ROM coal extracted from the trial may be handled through the adjacent VCM infrastructure before the construction of the Vulcan South CHPP has been completed.

The following chemicals and hydrocarbons will be required for processes in the CHPP, and will be stored on site:

- 215kL of diesel;
- Anionic flocculant (dry powder) 50m^3;
- Cationic flocculant (liquid) 50m^3; and
- Acrylate polymer 10m^3.

Rail Loop and TLO

Product coal will be railed from the Project rail loop onto the Goonyella Rail network. Export options include Dalrymple Bay to the north and RG Tanna, in Gladstone, to the south.

The train load out facility will link the product stockpiles with the proposed rail loop and will utilise a two-coal valve reclaim system to load at a rate of 3,500 tph. The train load out facility will be managed via an automated system, including overload protection and load veneering. The facility will be positioned over the rail line and will incorporate a suitable under rail spillage pit.

Water Management

To mitigate potentially adverse effects of mining and associated land disturbance, a water management system has been designed by WRM (**Appendix A**). The Project's water management system will include mine water drainage, mine water storages, sediment dams, pit water storages and flood protection works (i.e. levees).

The operational period of mining is expected to run for seven years from 2024 to 2031. **Figure 1-32** to **Figure 1-39** show indicative locations of the key features of the mine, including infrastructure related to the management of water on the Project site for three different stages of mining (Stages 1, 2 and 3). The main components of water-related infrastructure include:

- diverted water drains, bunds and drainage diversions to divert runoff from undisturbed catchments around areas disturbed by mining;
- flood protection levees along the southern side of the Vulcan North pit, along the western and south-eastern sides of the Vulcan Main pit, and around the Vulcan South pit;
- sediment dams and drains to collect and treat runoff from waste rock dumps; and
- mine-affected water drains and dams to store water pumped out of the open-cut pits and to collect runoff from the infrastructure areas.

The catchment areas of each of the water management types (surface water, mine affected water and diverted water) are also shown in **Figure 1-32** to **Figure 1-39**.

The water management system for the Project aims to protect the identified downstream environmental values and comprises the following key objectives:

- separate diverted water from mine-affected water to ensure that up-catchment water and mine-affected water do not mix wherever practicable;
- capture of mine-affected runoff (e.g. mine industrial area, haul road/ROM pad runoff), storage and priority reuse as mine water supply;
- divert up-catchment water runoff from upstream catchments around the active mining area;
- limit external catchment runoff draining into pits;
- manage sediment from disturbed catchment areas (e.g. ex-pit waste rock dumps, cleared/pre-strip areas) by using erosion and sediment control (ESC) measures prior to release offsite;
- reuse onsite water (e.g. mine-affected water) where possible to support mine operational water demands (and therefore limit mine-affected water inventories under normal operating conditions); and
- manage any mine-affected water releases to the receiving waters to meet environmental release conditions (not currently proposed).

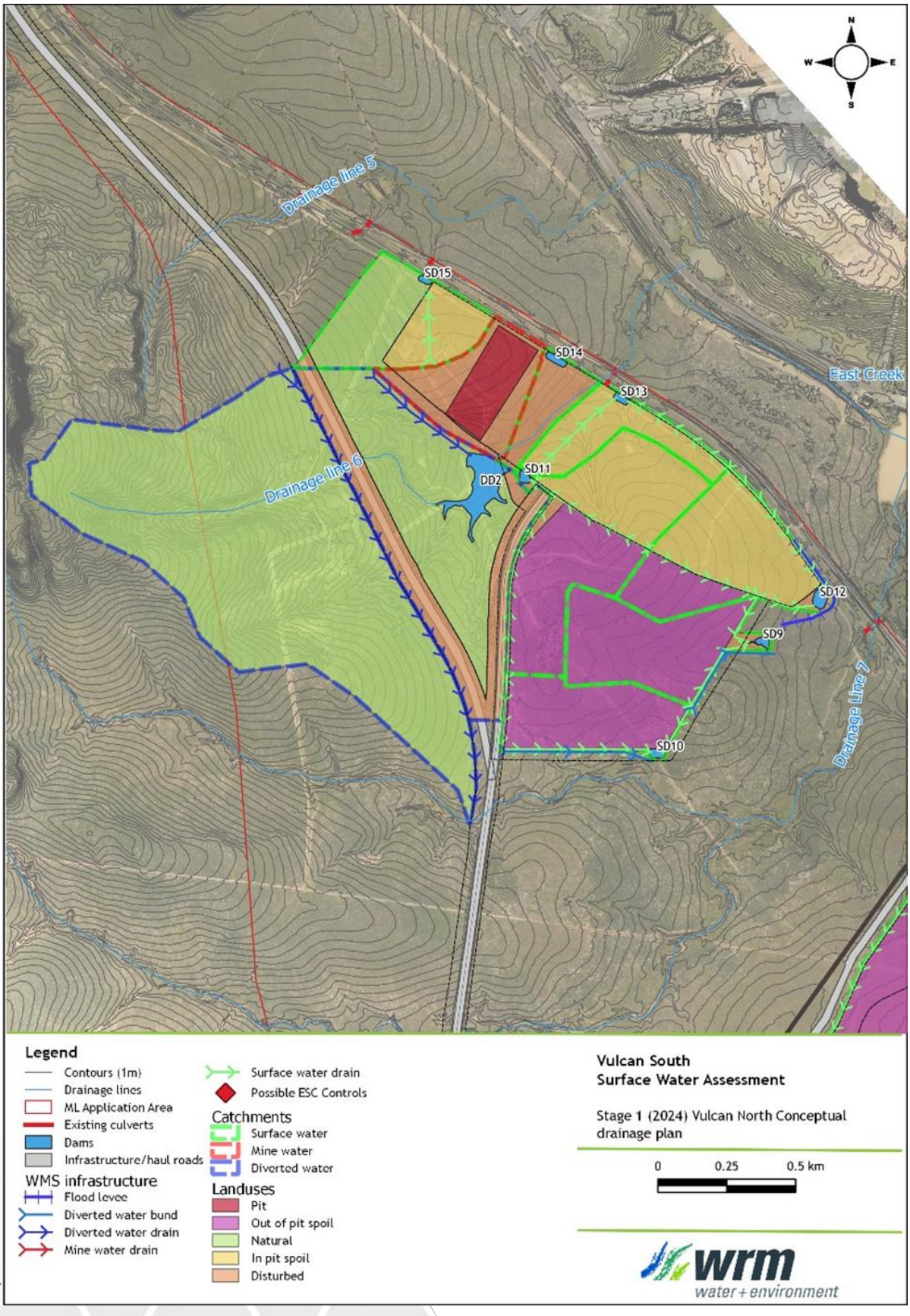


Figure 1-32 Stage 1 (Year 2024) Vulcan North mining area conceptual drainage plan

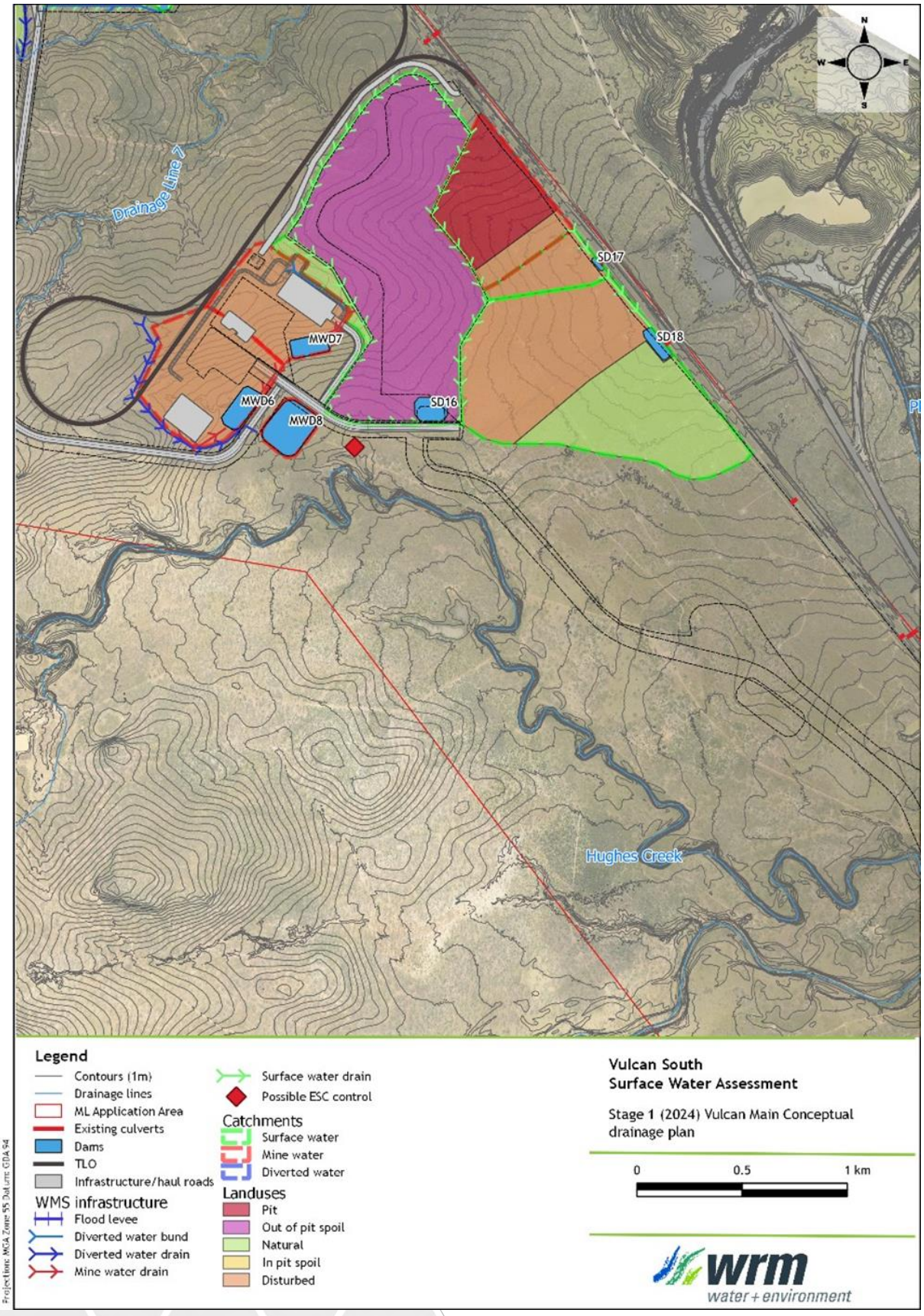


Figure 1-33 Stage 1 (Year 2024) Vulcan North mining area conceptual drainage plan

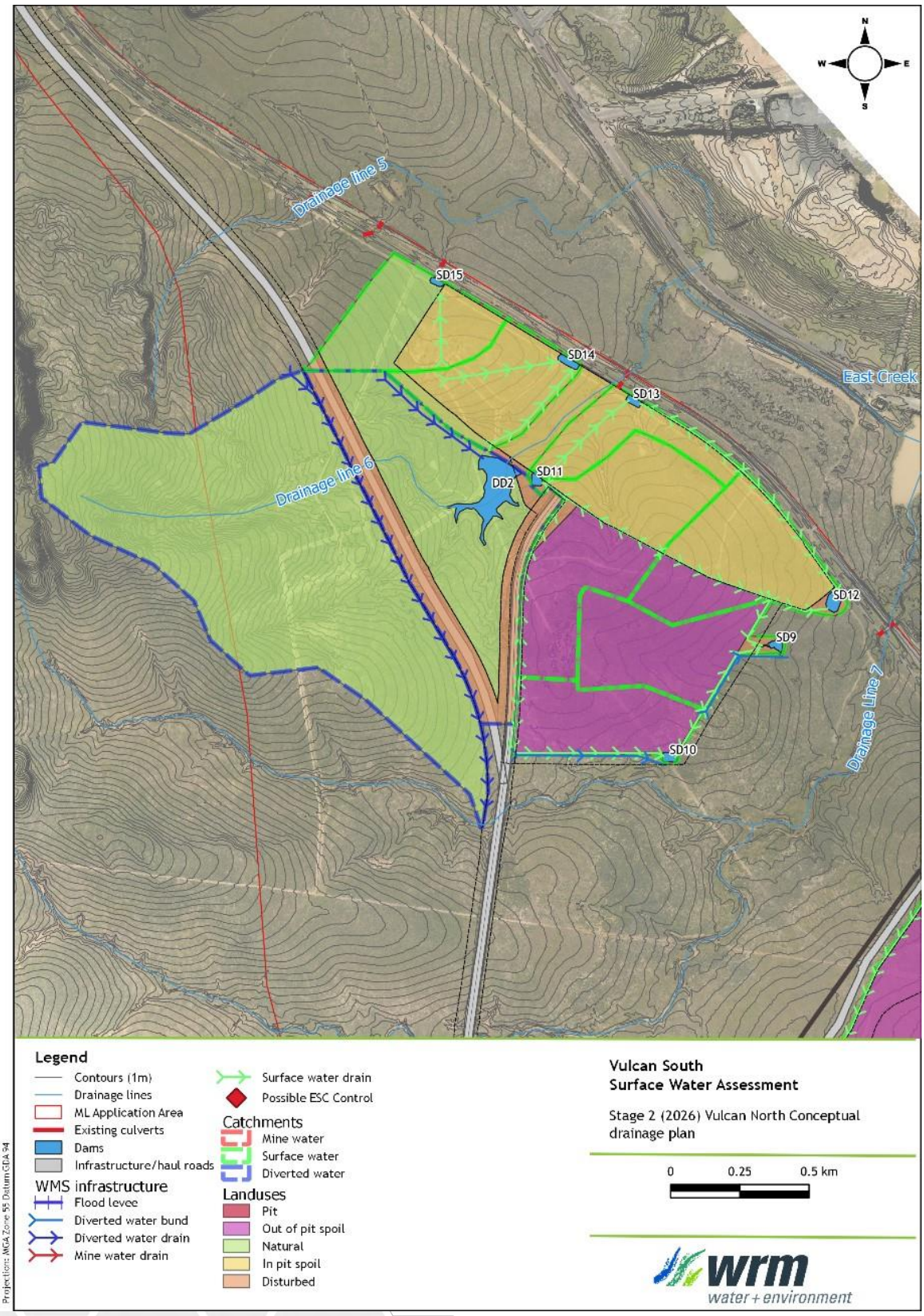


Figure 1-34 Stage 2 (year 2026) Vulcan North mining area conceptual drainage plan

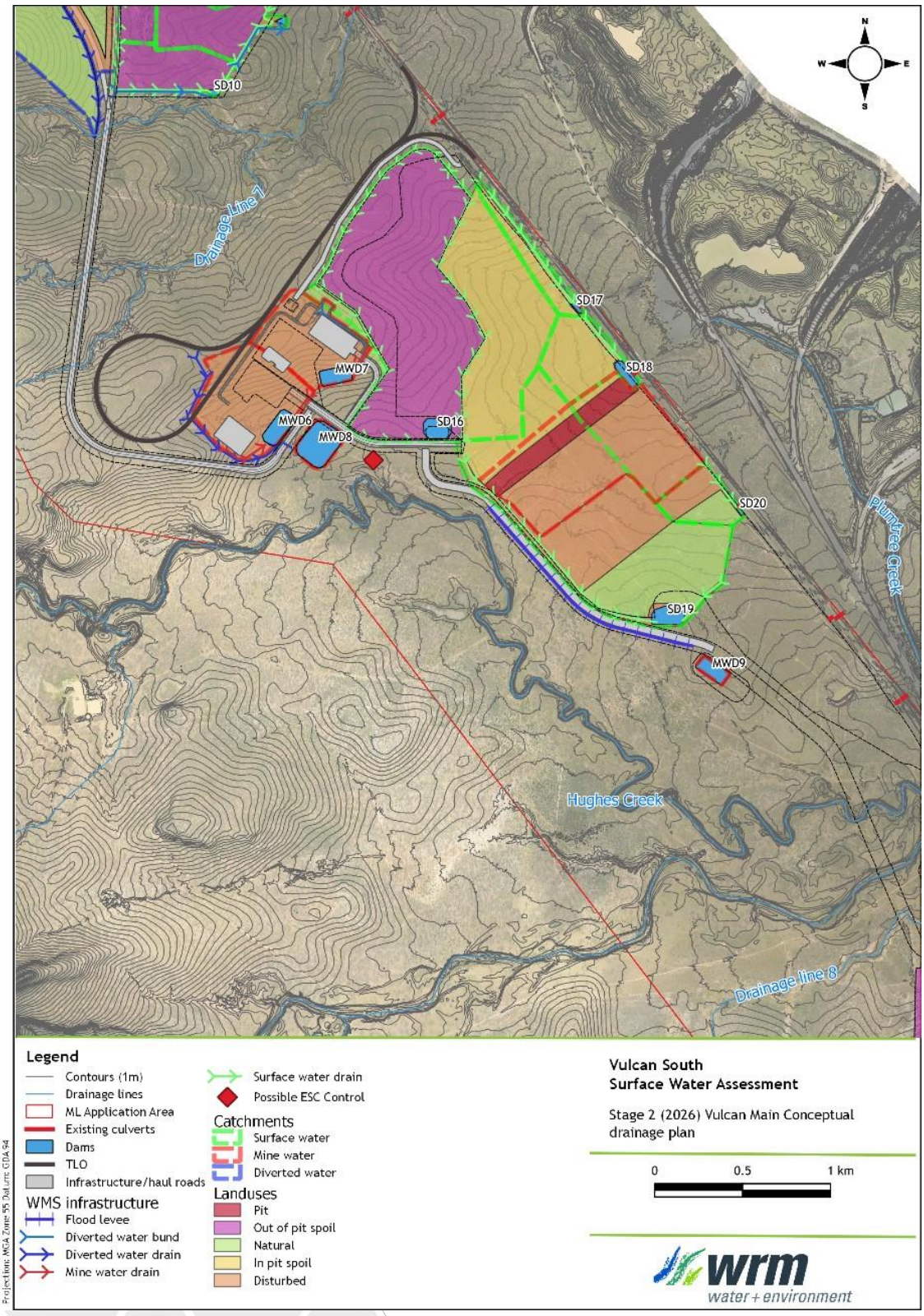


Figure 1-35 Stage 2 (year 2026) Vulcan Main mining area conceptual drainage plan

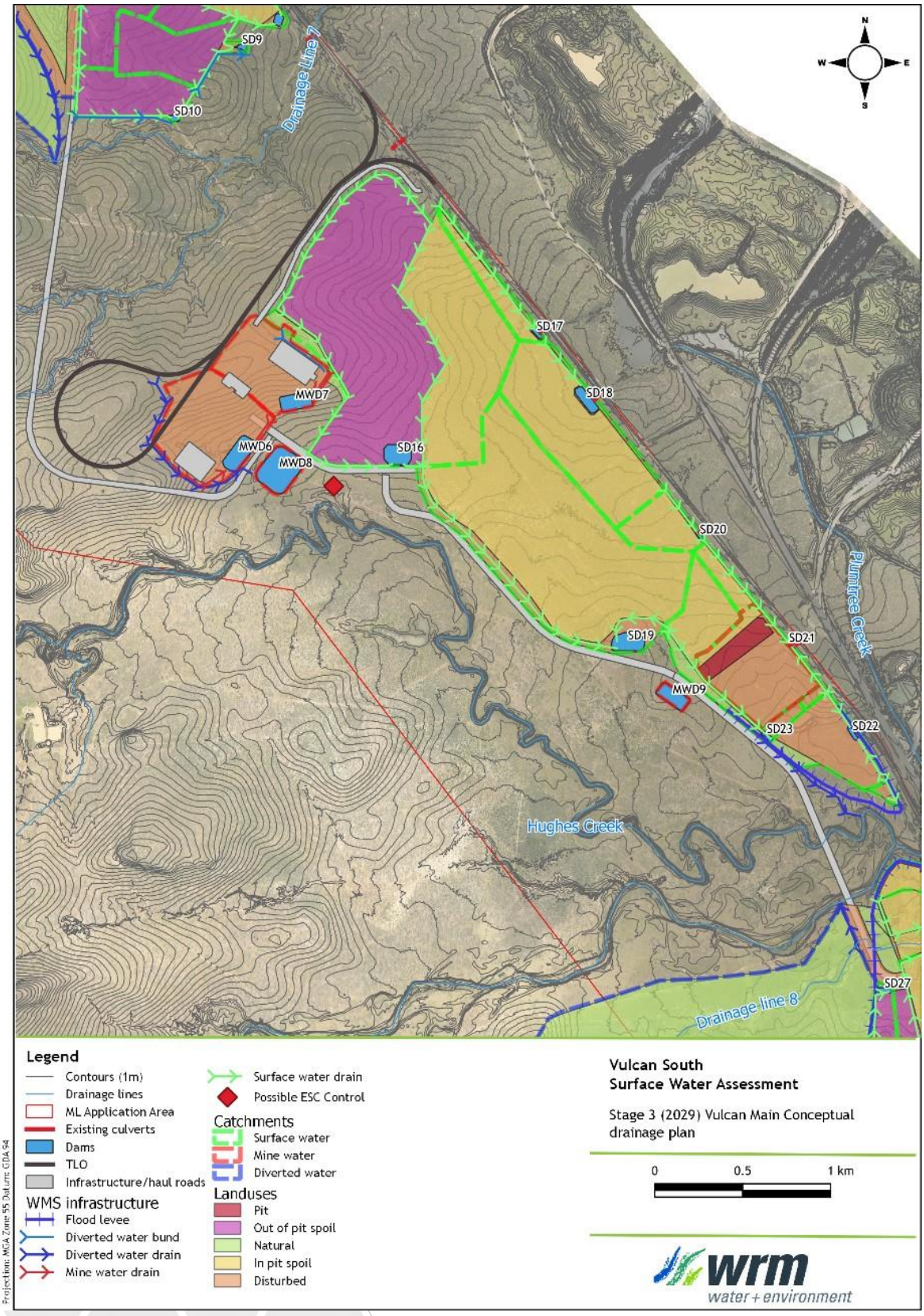


Figure 1-36 Stage 3 (Year 2029) Vulcan Main mining area conceptual drainage plan

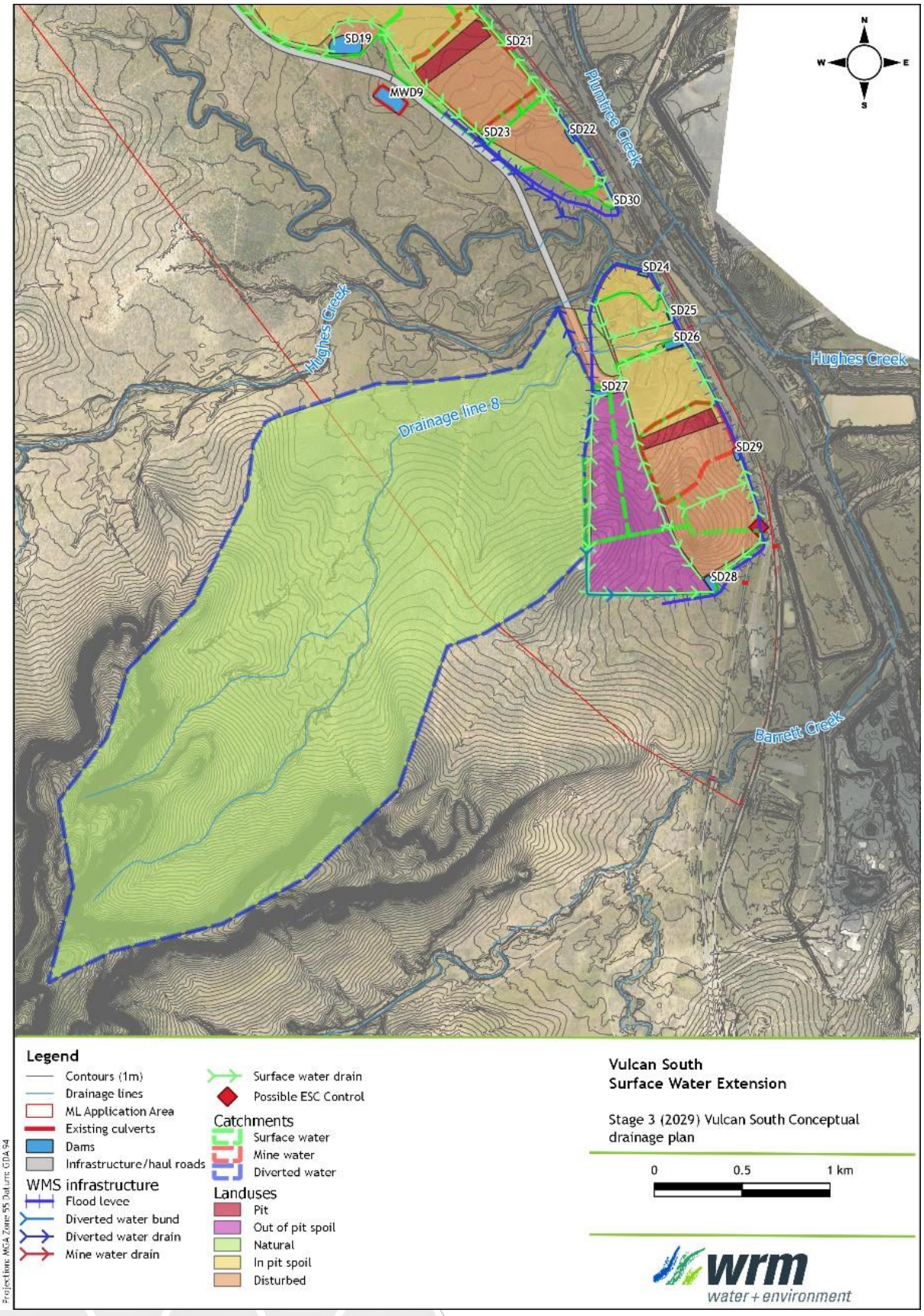


Figure 1-37 Stage 3 (Year 2029) Vulcan South mining area conceptual drainage plan

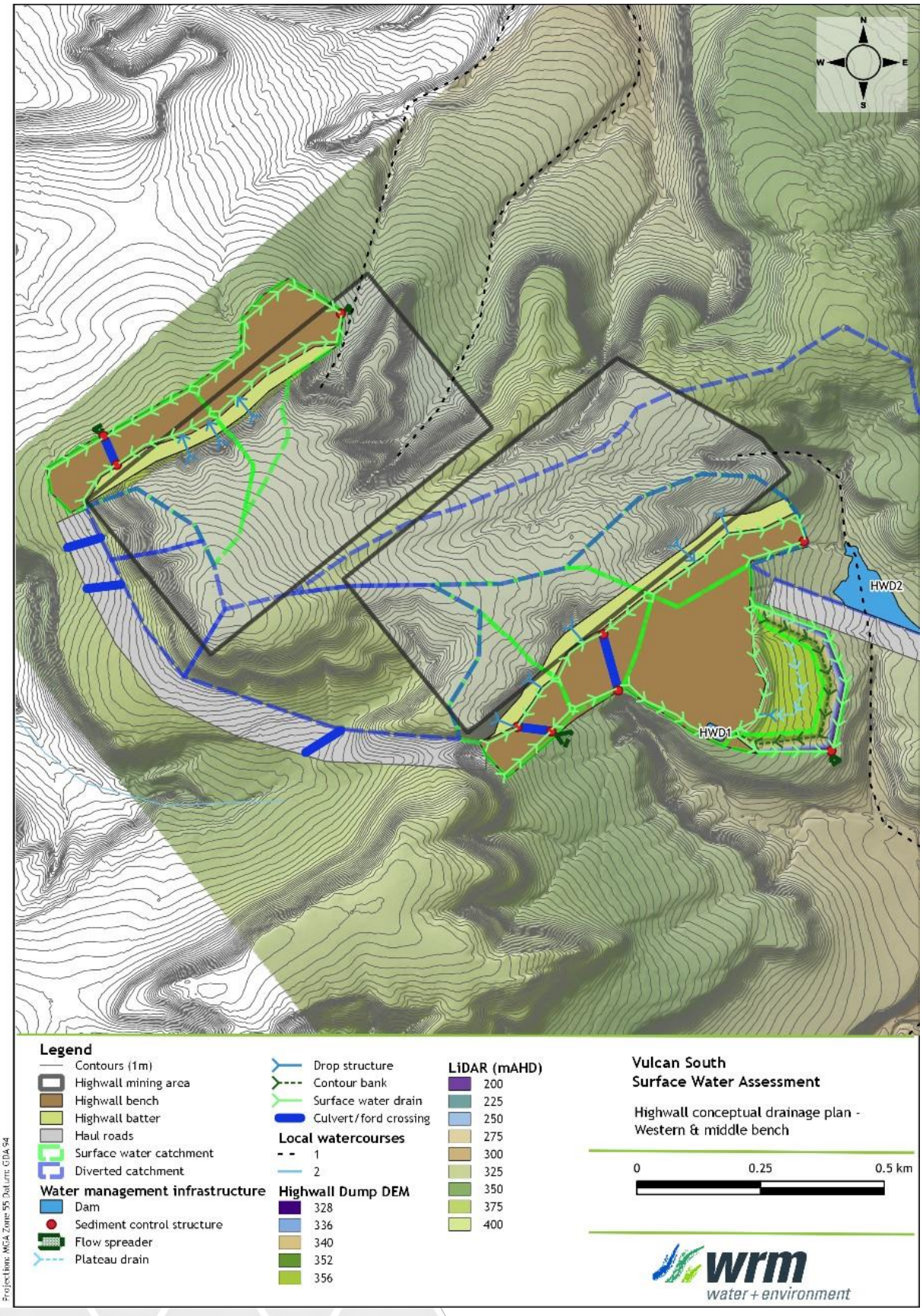


Figure 1-38 Highwall conceptual drainage plan – western & middle bench

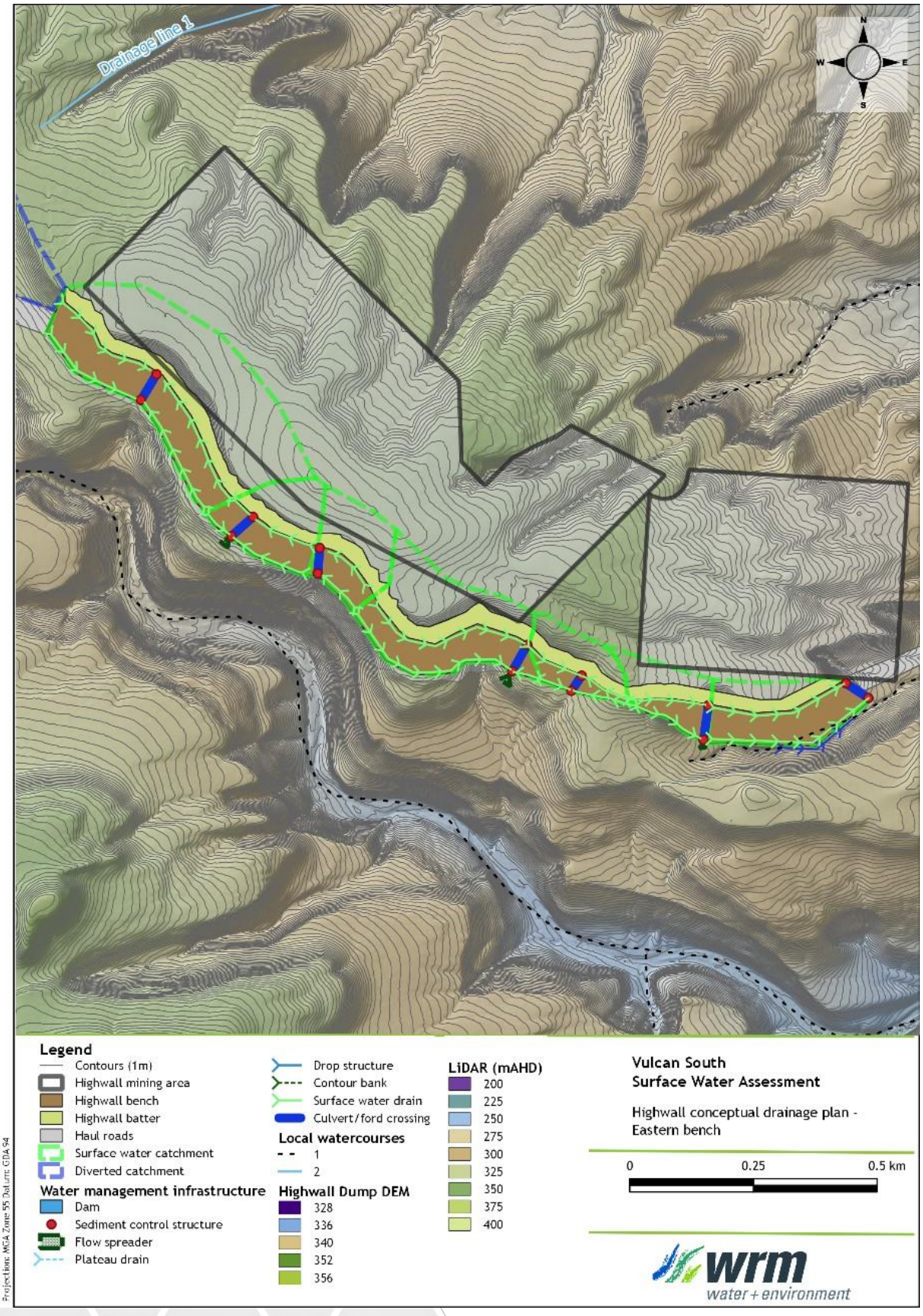


Figure 1-39 Highwall eastern bench mining area conceptual drainage plan

Diverted Runoff Water Management

A number of flood levees are proposed for the Project, including:

- Vulcan North levee on the southern edge of the Vulcan North pit to be constructed in Stage 1;
- Vulcan Main levee 2 on the western edge of the Vulcan Main pit to be constructed in Stage 2 and Vulcan Main levee 1 on the southern edge of the Vulcan Main pit to be constructed in Stage 3; and
- Vulcan South levee around the full extent of the Vulcan South pit to be constructed in Stage 3.

The flood levees will be regulated structures under the EP Act and will therefore be required to have a crest above the 0.1% AEP event.

The water management system has been designed to divert undisturbed catchments around mining operations wherever practicable. Three diverted water drains are proposed as part of the Project:

- drainage diversion 2 will be constructed in Stage 1 and will divert a catchment of approximately 105 ha away from the Vulcan North pit and dam DD2 (clean water storage dam as per Section 7.3.7.3 in **Appendix A**). This drainage diversion will collect an undisturbed catchment to the west of the Vulcan North pit and associated haul road. This drainage diversion will divert a portion of Drainage line 6 and discharge under a haul road to Drainage line 7 (which is a tributary of East Creek).
- drainage diversion 3 will be constructed in Stage 3 and will divert a portion of Drainage line 8 around the Vulcan South pit. This drainage diversion will collect an undisturbed catchment of approximately 570 ha and discharge to Hughes Creek.
- a minor drainage diversion diverts water southward around the Vulcan Main levee 1, to discharge into Hughes Creek.

A number of diverted water bunds are proposed in the vicinity of the three open cut pits. These bunds will collect runoff from minor catchments (i.e. smaller than 15 ha) where a drain is not deemed necessary and divert these catchments around mining operations.

2 LEGISLATIVE REQUIREMENTS

2.1 *Mineral Resources Act 1989*

Resource activities are regulated through a 'resource authority' under the *Mineral Resources Act 1989.* This provides resource companies with the right to enter land and undertake the approved activity. Under section 107(10) of this act, a mining claim can only be surrendered once improvement restoration (i.e., returning the tenement to substantially the same condition it was in before mining) has been carried out and the relevant environmental authority has been surrendered.

2.2 *Environmental Protection Act 1994*

The *Environmental Protection Act 1994* (EP Act) is the principal legislation for protecting environmental values potentially affected by the resource industry in Queensland. The EP Act grants the Queensland Government the power and means to assess, approve and prescribe conditions on proposed mining projects.

The EP Act requires that all areas of disturbed or undisturbed land within the relevant mining tenure be rehabilitated to a post-mining land use (PMLU), or managed as a non-use management area (NUMA). Section 125(1)(n) of the EP Act requires a proposed PRC Plan to accompany site-specific applications for a mining activity. Sections 126C and 126D stipulate the requirements for PRC Plans and PRC Plan schedules, respectively.

Under the EP Act, the Queensland Government is responsible for the issuing of an environmental authority (EA) to carry out a mining activity and approval of a PRC Plan schedule for a proposed PRC Plan. Under section 172(4) of the act, if the PRC Plan schedule is refused, the EA application must also be refused. Under sections 426(1) and 431A of the act, an applicant is unable to undertake any relevant activities until an EA with a PRC Plan schedule is approved. The EA and PRC Plan schedule includes all conditions imposed on the authority and schedule.

The EP Act also prescribes the requirements for surrendering an EA, including the preparation of final rehabilitation reports and post-mining management reports.

2.3 *Mineral and Energy Resources (Financial Provisioning) Act 2018*

In Queensland, the *Mineral and Energy Resources (Financial Provisioning) Act 2018* regulates a financial provisioning scheme for reducing potential risks to the Government in the event a holder of an EA fails to meet their environmental and rehabilitation obligations. This act also amended the EP Act to require mining companies to develop PRC Plans.

2.4 Progressive Rehabilitation and Closure Plans Guideline

This guideline, prepared by the Queensland Government Department of Environment and Science, contains information to assist applicants in developing a PRC Plan as part of a site-specific application for a new mining activity. The administering authority must consider this guideline when making a decision about a PRC Plan schedule under section 176A of the EP Act.

2.5 Rehabilitation Requirements for Mining Resource Activities

This guideline has been prepared by the Queensland Government Department of Environment and Science to assist mining companies to propose acceptable rehabilitation outcomes and strategies. The administering authority must consider this guideline when making a decision about a PRC Plan schedule under section 176A of the EP Act.

2.6 *Environment Protection and Biodiversity Conservation Act 1999*

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) is the Australian Government's key piece of legislation protecting matters of national environmental significance.

Actions that will or are likely to impact matters of national environmental significance require approval from the Environment Minister under the EPBC Act. Any conditions attached to this approval that pertain to rehabilitation of the site after mining must be adhered to under the EPBC Act.

3 STAKEHOLDER ENGAGEMENT

3.1 Stakeholder Consultation Register

A Stakeholder Engagement Plan (SEP) that complies with section 126C(1)(c)(iv) of the EP Act was prepared to guide stakeholder engagement activities associated with project planning, the environmental approvals process and the development of the PRC Plan (**Appendix E**).

In accordance with section 126C(1)(c)(iv) of the EP Act, the SEP also discusses ongoing stakeholder engagement during progressive rehabilitation and closure.

Given that the proposed PMLUs seek to re-establish, for the most part, the current site land uses, the key stakeholders for rehabilitation of the site were deemed to be:

- the owners of the properties listed in **Table 1-9**;
- the Barada Barna People, as native title holders for the broader project area;
- neighbouring and downstream water users (BHP Billiton/Mitsubishi Alliance (BMA));
- Isaac Regional Council;

In addition to the above stakeholders, relevant stakeholders for the development of the Project also include:

- nearby businesses (BHP Billiton Mitsubishi Alliance (BMA) Pty Ltd; and Saraji Station);
- Queensland Department of Environment and Science (DES);
- Queensland Department of Resources (DoR);
- Queensland Department of Transport and Main Roads (DTMR); and
- Commonwealth Department of Climate Change, Energy, the Environment and Water (DCCEEW)

Given the small scale and short duration of the Project and the proposal to return the land to its pre-mine land use, it is considered unlikely that stakeholder perspectives on PMLUs will change significantly during the course of progressive rehabilitation, particularly if the proposed rehabilitation activities are implemented successfully as anticipated.

Vitrinite will provide relevant stakeholders with copies of the annual rehabilitation progress return. These annual rehabilitation progress returns will be the principal mechanism for communicating any proposed changes to the PRC Plan, and to obtain feedback from stakeholders for consideration in ongoing planning and activities. Should significant amendments of the PRC Plan be proposed, stakeholders will be engaged as part of the amendment process.

Further detail regarding the PRC Plan annual reporting mechanism is outlined in **Section 9.1.12.**

3.2 Stakeholder Consultation Plan

A stakeholder consultation register that complies with section 126C(1)(c)(iii) of the EP Act is appended to the Project's SEP (**Appendix E**).

The stakeholder consultation register is a record of all consultation activities, describing the attendees, topics of discussion, outcomes and ongoing commitments for each consultation meeting.

During the consultation process outlined above, topics of discussion with stakeholders have included the proposed rehabilitation approach, the plan for the mine, PMLUs, areas of disturbance, rehabilitation and management methods, progressive rehabilitation and closure timeframes.

4 POST-MINING LAND USE

The MLA hosted three land uses prior to the mine. Most of these land uses are to be reinstated as post-mining land uses (PMLUs) once operations cease, except for the rail corridor which will not qualify as a PMLU considering it will not be disturbed and therefore will not require a rehabilitation area.

Most of the MLA area will have a PMLU of native ecosystems non-riparian. Locally native plant species are to be incorporated into the planting mixes to create land that restores habitat values for threatened fauna (namely, the Squatter Pigeon, Greater Glider and Koala) impacted by the mine.

The proposed PMLU's are:

- Low-intensity cattle grazing;
- Native ecosystems non-riparian;
- Native ecosystems riparian;
- Saraji Road; and
- Rail corridor.

In accordance with the *Environmental Protection (Rehabilitation Reform) Amendment Regulation 2019*, a PMLU:

- is viable, having regard to the use of land in the surrounding region;
- is consistent with how the land was used before a mining activity was carried out on the land;
- is consistent with a use of the land permitted under the *Planning Act 2016*; and
- will deliver, or aim to deliver, a beneficial environmental outcome.

The locations of these PMLUs are described within the PRC Plan schedule (**Section 10.4**) and presented in **Figure 10-2**. Through in-pit dumping of waste rock, no voids will remain on site after mining. Consequently, no non-use management areas (NUMAs) are proposed.

Based on previous studies, grazing is an achievable PMLU in the Bowen Basin (Bisrat *et al.* 2004). To achieve the proposed PMLU, rehabilitated land should have a land suitability class of at least 4 (marginal land for grazing), which was the dominant land suitability class on site prior to mining. Only areas where grazing was an existing land use prior to the mine, has it been proposed as a PMLU.

Native ecosystems in both riparian and non-riparian settings are also proposed PMLUs. Native plant species will be incorporated into seed mixes based on dominant species of trees, shrubs and grasses present within each soil management unit within the Project area prior to mining. Reinstating the vegetation communities that were present prior to the commencement of mining activities will provide habitat and connectivity, along with providing beneficial environmental outcomes.

Other PMLUs considered included "forestry" (hardwood *Eucalyptus* plantations) and "agriculture" (dryland cropping), but the limited topsoil materials and high cost of creating a productive growing medium with the materials available limit the feasibility of both options (see **Section 4.3** for an assessment of each option).

4.1 Accordance with Stakeholders' Requests

Through the consultation process undertaken for the development of this PRC Plan, all relevant stakeholders expressed support for the proposed PMLUs.

4.2 Regulatory Constraints

There are relatively few regulatory constraints on the post mining land use on the MLA. These are discussed below.

4.2.1 Isaac Regional Planning Scheme

Under the *Isaac Regional Planning Scheme*, the Project is located in a "Rural" zone. The Isaac Regional Planning Scheme defines uses suitable for "Rural" zones as cropping, intensive horticulture, aquaculture, grazing, intensive animal industries, renewable energy facilities and extractive industries. These defined uses are consistent with the PMLUs for the Mine.

4.2.2 Mackay, Isaac and Whitsunday Regional Plan

The Queensland Government, via their *Mackay, Isaac and Whitsunday Regional Plan*, maps the Project in a "regional landscape and rural production area", which includes land used for agriculture, water catchment, traditional uses, conservation areas and native forests. The PMLUs are consistent with these planned land uses.

The highwall trial area and land to the west of the proposed pits is mostly mapped as being of "high ecological significance" under the *Mackay, Isaac and Whitsunday Regional Plan*. This plan aims to minimise the impact of development on such areas of high ecological significance, and a PMLU that is compatible with restoring many of the original environmental values is consistent with this regional plan.

4.3 Assessment of Options

Four potential PMLUs were assessed as part of planning for the Project:

1) Low-intensity cattle grazing with low- to medium-density of native trees;
2) Native vegetation communities (native ecosystems);
3) Hardwood (e.g., *Corymbia citriodora*) plantation forestry; and
4) Dryland cropping.

These PMLUs were selected because they are land uses consistent with the *Isaac Regional Planning Scheme* and the *Mackay, Isaac and Whitsunday Regional Plan*.

In order to compare the relative merit of each PMLU option, a scoring system was applied across ten costs and benefits, in accordance with the *Progressive Rehabilitation and Closure Plans Guideline* (**Table 4-1**). This awarded a score of 1-5 for each consideration (cost/benefit), with the sum of all scores across considerations used to compare PMLU options. Even though different rehabilitation areas have slightly different rehabilitation methods and milestones, they are assessed together due to their similar constraints.

This assessment revealed that low-intensity grazing and native vegetation communities were the most appropriate PMLUs for the Project (**Table 4-1**). The overall scores were similar for both, with grazing being marginally favourable on flat terrain and native ecosystems being marginally favourable in steeper sandstone areas.

There are other reasons, not considered in **Table 4-1**, why forestry and cropping are considered risky options for the Project. In Queensland, plantation forestry is largely limited to coastal regions, and the performance of plantations is untested within the Isaac Regional Council area. Cropping is also a land use associated with high risk, given the highly dispersive subsoils across most of the Project area (see **Section 1.2.7**). Regular cultivation of the topsoil is likely to expose these subsoils to erosion, with irreversible outcomes.

According to the *Rehabilitation Requirements for Mining Resource Activities v2.01*, optimal PMLUs are those highest up in the following hierarchy:

1) avoid disturbance that will require rehabilitation;
2) reinstate a "natural" ecosystem as similar as possible to the original ecosystem;
3) develop an alternative outcome with a higher economic value than the previous land use;
4) reinstate previous land use (e.g. grazing or cropping);
5) develop lower value land use; and
6) leave the site in an unusable condition or with a potential to generate future pollution or adversely affect environmental values.

The two favoured PMLUs, native ecosystems and low-intensity cattle grazing, fall 2nd and 4th on this hierarchy, respectively. While cropping would fall 3rd, the physical and chemical constraints of the site, and the relative costs of ameliorating the topsoil to enable productive crop growth, preclude this as a viable option.

Table 4-1 Assessment of PMLU options

Considerations	PMLU Options*				Justification
	Low-intensity grazing	Native ecosystems	Forestry	Cropping	
Physical constraints	4	4	3	2	Shallow soil, sloping land and a hot/dry climate with limited access to irrigation mean that no land use achieves a score of "5". However, these are relatively minor constraints on re-establishing grazing or native ecosystems. Forestry is largely untested in such a dry climate, so this is awarded a neutral score of "3". Cropping is strongly limited (though not impossible) by the lack of access to irrigation and the thin, sandy soil and is awarded a score of "2".
Chemical constraints	4	4	2	1	Topsoil has poor nutrient-holding capacity, while subsoils are generally dispersive. These attributes largely preclude cropping as an option. They also pose substantial constraints on the performance of forestry, given that stressed trees are less likely to produce a desirable form for milling. While chemical constraints also affect the re-establishment of grazing and native ecosystems, this limitation is relatively minor.
Available materials	4	4	2	1	No land use has a score of "5" due to limited amounts of fresh topsoil that can be directly deposited onto disturbed areas (most soil requires some period of stockpiling, which reduces its quality as a growing medium). Nevertheless, this is expected to be a minor limitation for re-establishing grazing or native ecosystems as land uses. As forestry is an undeveloped industry in this climatic zone, strains of timber trees that perform well in local conditions would need to be investigated and mass-produced, something that is not likely to be achievable in the short timeframe of the Project. For cropping to be viable, existing soil would need to be overlaid with large quantities of suitable topsoil, to provide a favourable growing medium for crops and protect underlying soils from dispersion/erosion. Such material is unavailable.
Relative cost	4	3	2	1	The scores awarded reflect the costs of obtaining the materials required to instate each land use, and therefore generally reflect the scores awarded for material availability. The reason that grazing is slightly cheaper to instate than native ecosystems is due to the relatively simpler plant communities to be established on pastoral land. Restoring native ecosystems would require a more complex seed mix, which is more costly to collect/obtain.

Considerations	PMLU Options*				Justification
	Low-intensity grazing	Native ecosystems	Forestry	Cropping	
Economic benefits for the community or landholder	4	1	3	5	Scores were based on the potential gross annual income generated from each land use once each has been instated. It is independent of the relative costs described above.
Environmental benefits	3	5	2	1	Scores were based on the biodiversity of native flora that are likely to coexist with the land use, ranging from 5 = full diversity in native ecosystems, to 1 = no native species in crops. Forestry could vary from 2 to 4, depending on the dominance of weeds vs native species in the understorey. It is assumed that, as few native species are expected to regrow in stockpiled soils without active addition of seed, forestry would most likely create a monoculture of timber trees with few native species below. As a diversity of native grasses and trees will be planted in land used for grazing, biodiversity in this land use will be moderate (3).
Social value (recreation, public amenity, employment)	2	2	3	4	High scores were awarded for land uses dependent on a regular supply chain of materials, machinery or labour (maximising employment, for example cropping and, to a lesser extent, forestry). Moderate scores were also awarded for land uses that provide scenic amenity (forestry, native ecosystems), and/or those compatible with recreational activities such as bushwalking or hunting. Scores tended to be relatively similar across potential land uses, as the land uses providing maximum employment opportunities tended to have fewer recreational or public amenity benefits.
Compatibility with surrounding land uses	5	5	3	3	Grazing, native ecosystems and mining are the predominant surrounding land uses. Therefore, grazing and native ecosystems are fully compatible, while forestry and cropping are neutral. The latter two options will require application of water, fertiliser and/or pesticides, which may impact neighbouring land uses. However, this incompatibility is minor.
The land use before mining commenced	5	5	1	1	Land-uses in place on site prior to mining are awarded "5" and those not in place are awarded "1".
Compatibility with planning instruments under the *Planning Act 2016*	5	5	5	5	All options are fully compatible with the *Isaac Regional Council Planning Scheme* and the *Mackay, Isaac and Whitsunday Regional Plan.*
Total Score	**40**	**38**	**26**	**24**	

*For each consideration, each PMLU option is awarded a relative score (1-5), where 5 is feasible/desirable and 1 is prohibitive/undesirable. The sum of the scores across all considerations was used to compare the favourability of each option.

4.4 Statutory Constraints to be Imposed

Due to the absence of NUMAs or reactive waste rock material, and the fact that the final landform will generally resemble the surrounding landscape, few statutory constraints are expected to be imposed on future land managers of the Vulcan South area.

Any restrictions on the future stocking rates are to be described in the Post-mining Management Report (see **Section 9.6**) and imposed through a Site Management Plan, to be adopted by future land managers of the site. This is to be confirmed following pasture development and performance monitoring.

5 REHABILITATION GOALS

Under section 176A (3)(c)(i) of the EP Act, mined land must be rehabilitated to a stable condition. Land is in a stable condition, as defined in section 111A of the EP Act, if: (a) the land is safe and structurally stable, (b) there is no environmental harm being caused by anything on or in the land; and (c) the land can sustain a post-mining land use. These three components of stability are the general rehabilitation goals for all areas disturbed by mining in Queensland. They have been developed from the ecologically sustainable development (ESD) policy framework, especially in relation to intergenerational equity, polluter pays principle, protection of biodiversity, and maintenance of essential ecological processes.

5.1 Rehabilitation Objectives, Indicators and Completion Criteria

A clearly defined set of rehabilitation objectives has been developed for each PMLU proposed for the Project. For each objective, one or more rehabilitation indicators (measurements of progress towards the rehabilitation objectives) are proposed. These indicators are designed to be auditable against completion criteria, which act as targets for the rehabilitation process. Each completion criterion is applied to the PRC Plan Schedule as a milestone criterion for the later stages of rehabilitation. The full list of rehabilitation objectives, indicators and completion criteria is shown in **Table 5-2**. For details about how each indicator is to be measured, refer to **Section 9**.

The final PMLU's for the project are summarised in the table below, together with which rehabilitation area they occur within.

Table 5-1 PMLU location within footprint

PMLU	Location within footprint	Explanation
Low-intensity cattle grazing	Located within the main in-pit (RA5) and ex-pit WRD (RA2), haul roads (RA7) and water management infrastructure in previously cleared areas (RA9).	These rehabilitation areas are located in areas used for cattle grazing prior to mine development and therefore this PMLU remains consistent with the pre-mining land use.
Native ecosystems non-riparian	Located within the North and South Ex-pits (RA1) and in-pits (RA4) WRD, all previously wooded areas used for infrastructure (RA6) and water management (RA8) and the highwall mining area (bench dams, ex-pit WRD - RA10)	All areas previously wooded that are not classed as riparian habitat are to be reinstated as native ecosystems to minimise loss to threatened species habitat.
Native Ecosystems riparian	Reinstated watercourses (RA3).	All previously designated watercourses will be reinstated with their pre-mining land use.
Saraji Road	Along the eastern ML boundary	This PMLU is part of an agreement between Vitrinite and Isaac Regional Council (IRC). The realigned road's construction and commissioning will be in accordance with conditions specified in the agreement.
Rail corridor	Along the eastern ML boundary	This will not form part of any rehabilitation area because it is expected that it will exist well beyond the life of the project and no specific disturbance or rehabilitation activities are proposed.

Refer to Figure 10-2 for rehabilitation areas.

Table 5-2 Rehabilitation objectives, indicators and completion criteria

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
Low-intensity cattle grazing					
A1	Land is to be stable	a) Depth of active rills and gullies. b) Groundcover benchmarks for different slopes c) Erosion monitoring d) Geotechnical stability e) All corrective actions where required	Sites are to be monitored at the time of planting and then every two years for 10 years after planting.	a) No active rill or gully erosion deeper than 25 cm present. b) Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 70% on slopes with a gradient lower than 10%; c) -Erosion monitoring has been completed; -no active rill or gully erosion deeper than 30 cm present; -there is no evidence of erosion classified as 'moderate' or 'severe' as defined by the approved PRCP Schedule for EA100265081 d) A suitably qualified person has certified that the final landform is geotechnically stable; e) All corrective actions recommended by suitably qualified persons in response to erosion or deficient vegetation cover have been implemented;	a) Provides a supplementary observational method of early erosion detection and early intervention. b) This is informed by the Reef protection regulations – Farming in Reef catchments: Grazing Guideline 2022 classification in land considered to be 'good or in fair condition for grazing'. This percentage is derived from studies indicating high rates of erosion are likely where ground cover is less than 50 percent (Roth, et al., 2004). c) This provides surety that erosion monitoring is completed. d) Confirmation that the land is stable from a geotechnical perspective ensures long term stability of the final landform. e) This ensures that following the completion of erosion monitoring, management actions are undertaken to remediate any shortfalls in rehabilitation outcomes.

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
A2	Land is to be non-polluting	Surface water quality at permanent monitoring locations downstream of the Project.	Monthly, subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the Project would be reviewed and updated accordingly.	All downstream surface water quality parameters at permanent locations (**Table 9-5**) are to remain within site specific water quality monitoring limits listed in Table F3 of the approved Environmental Authority (**Table 9-7**)';	Site-specific surface water quality triggers are based on baseline surveys undertaken at the site.
		Groundwater quality within permanent monitoring bores	Quarterly, to demonstrate the receiving waters quality is within the trigger values for the Project. Subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the Project would be reviewed and updated accordingly.	Groundwater in downgradient monitoring locations remains within site-specific water quality monitoring limits as outlined in Table E1 and E2 of the Environmental Authority.	Site-specific surface water quality triggers are based on baseline surveys undertaken at the site.

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
A3	Weeds listed under the *Biosecurity Act* are not to exceed densities typically present in unmined, grazed landscapes within the MLA and neighbouring areas.	Percentage cover within a 10 m × 50 m plot	Between February and April, every two years for 10 years after planting.	Rehabilitated areas are to have ≤0.2% cover of *Parthenium hysterophorus* **AND** rehabilitated areas are to have ≤0.1% of *Harrisia martinii* **AND** Any other weeds listed under the *Biosecurity Act* are to be present in densities of <1 individual per hectare.	Completion criteria are based on the densities of each weed recorded during ecological surveys of the region prior to mining (METServe, 2022). As weed densities vary by soil type, only data from soil types present within the MLA area are incorporated into the completion criteria.
A4	Pasture is to be as productive within rehabilitated areas as in neighbouring unmined areas within the same soil management unit.	Pasture mass (t/ha) of ungrazed plots	Sites are to be monitored at the end of the growing season (April-May) six and ten years after planting.	Perennial pasture cover >50%; Rehabilitated areas have a pasture biomass that is not >10% less than pasture biomass on unmined areas with the same soil management unit measured at the same time, as measured under both wet and dry conditions;	Pasture mass is the standard unit of productivity used widely in the grazing industry (Cayley and Bird 1996).
A5	Rehabilitated land is to have the same land suitability class for grazing as pre-mining score.	Land suitability class	Sites are to be monitored six and ten years after planting.	Rehabilitated areas are to have a land suitability class of 3 or lower.	Prior to mining, the land had a suitability class for cattle grazing of 4 (AARC 2022).

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
A6	The species richness of grasses that make up the pasture in rehabilitated areas is to be as high as in neighbouring unmined areas within the same soil management unit.	Species richness (number of species) of grasses contained within a 10 m × 50 m plot.	Sites are to be monitored soon after planting (Feb-Apr) and then every two years for 10 years after planting.	The species richness of plots in rehabilitated areas is to equal or exceed the 10th percentile among equivalent plots in reference sites on the same soil management unit.	Because the relative densities of each species are expected to differ between rehabilitated and reference sites due to differences in grazing history (reference sites are all grazed), species richness is favoured as an indicator over indices of diversity (the latter incorporate relative abundance).
A7	Achieving milestone criteria during drought conditions	Sites fulfil criteria during drought conditions	Following a "drought" year	Sites fulfil all other milestone criteria after having experienced at least one "drought" year (defined as having a total rainfall over a 12-month period that falls within the lowest decile recorded at the nearest weather station.	Demonstrate the resilience to drought conditions.
Native ecosystems non-riparian					

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
B1	Land is to be stable	a) Indices of Landscape Function Analysis (Tongway and Hindley 2004). b) Depth of active rills and gullies. c) Groundcover benchmarks for different slopes d) Erosion monitoring e) Geotechnical stability f) All corrective actions where required	Sites are to be monitored at the time of planting and then every two years for 10 years after planting.	a) Landscape function analysis scores for soil stability, infiltration/runoff and nutrient cycling have started to plateau, and the plateau values predicted from sigmoidal curves fitted to the data are equivalent to or exceed values at analogue sites. b) No active rill or gully erosion deeper than 25 cm present. c) Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower then 10%; d) Erosion monitoring has been completed; e) A suitably qualified person has certified that the final landform is geotechnically stable; f) All corrective actions recommended by suitably qualified persons in response to erosion or deficient vegetation cover have been implemented;	a) This methodology has been widely applied to rehabilitated mine sites across Australia, and is strongly correlated with soil aggregate stability, soil nutrient cycling and water infiltration (Tongway and Hindley 2004). b) Provides a supplementary observational method of early erosion detection and early intervention. c) This is informed by the Reef protection regulations – Farming in Reef catchments: Grazing Guideline 2022 classification in land considered to be 'good or in fair condition for grazing'. This percentage is derived from studies indicating high rates of erosion are likely where ground cover is less than 50 percent (Roth, et al., 2004). d) This provides surety that erosion monitoring is completed e) Confirmation that the land is stable from a geotechnical perspective ensures long term stability of the final landform. f) This ensures that following the completion of erosion monitoring, management actions are undertaken to remediate any shortfalls in rehabilitation outcomes

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
B2		Percentage cover of rock, woody debris, litter, grasses and herbs within a 10 m × 50 m plot.	Late wet season (February-May), every two years for 10 years after planting.	The species richness of grasses within 10 m x 50 m plots in rehabilitated areas is to equal or exceed the 10th percentile among equivalent plots in reference sites on the same soil management unit;	A percentage cover of ≥50% protects slopes from erosion (Loch 2000; Waters 2004; Carroll *et al.* 2010). Cover ≥70% is required to achieve background rates of erosion on slopes steeper than 10% (AARC 2022). Excessive groundcover inhibits the recruitment of trees and shrubs, and a maximum value of 96% cover was observed within reference sites in stable, unmined vegetation communities (METServe 2022).
		Natural recruitment of flora species	Late wet season (February-May), every two years for 10 years after planting.	At least 60% of established species show natural recruitment;	Important for demonstrating the majority of vegetation is naturally recruited to indicate successful rehabilitation.
B3	Land is to be non-polluting	Water quality at permanent monitoring locations downstream of the Project.	Monthly, subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the Project would be reviewed and updated accordingly.	All downstream surface water quality parameters at permanent locations (**Table 9-5**) are to remain within site specific water quality monitoring limits listed in Table F3 of the approved Environmental Authority (**Table 9-7**)';	Site-specific surface water quality triggers are based on baseline surveys undertaken at the site.

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
		Groundwater quality within permanent monitoring bores	Quarterly, to demonstrate the receiving waters quality is within the trigger values for the Project. Subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the Project would be reviewed and updated accordingly.	Groundwater in downgradient monitoring locations remains within site-specific water quality monitoring limits as outlined in Table E1 and E2 of the Environmental Authority.	Site-specific surface water quality triggers are based on baseline surveys undertaken at the site.
B4	Weeds listed under the *Biosecurity Act* are not to exceed densities typically present in unmined, grazed landscapes within the MLA and neighbouring areas.	Percentage cover within a 10 m × 50 m plot	Between February and April, every two years for 10 years after planting.	Rehabilitated areas are to have ≤0.2% cover of *Parthenium hysterophorus* **AND** rehabilitated areas are to have ≤0.1% of *Harrisia 94artini* **AND** Any other weeds listed under the *Biosecurity Act* are to be present in densities of <1 individual per hectare.	Completion criteria are based on the densities of each weed recorded during ecological surveys of the region prior to mining (METServe, 2022). As weed densities vary by soil type, only data from soil types present within the MLA area are incorporated into the completion criteria.

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
B5	Koala food trees are to have a similar dominance within rehabilitated vegetation communities as they did in vegetation present on site prior to mining	a) With the exception of a non-permanent cover crop species, the seed mix to satisfy RM5.1 contains only those species listed in **Table 6-6** List for the relevant PMLU and reflect the regional ecosystem distribution spatially shown in **Figure 1-16**. b) BioCondition benchmark criteria for non-riparian and riparian PMLU's as per **Table 9-3**	Sites are to be monitored six and ten years after planting.	A rehabilitation performance assessment completed under RM7.3 achieves a score of at least 40/80 of the reference site based on the benchmark criteria in **Table 9-3** for the relevant native ecosystem-non-riparian PMLU.	Relative dominance of Koala food trees is based on secondary site data gathered from nine sand plain reference sites and three riparian reference sites (METServe, 2022). By applying milestone criteria that refer to minimum target BioCondition scores, instead of specific benchmark targets for constituent vegetation characteristics, the criteria are achievable for developing rehabilitated ecosystems and permit variation in the local composition of these ecosystems (by using the benchmarks for the relevant regional ecosystem when calculating BioCondition at each survey site).
B7	Achieving BioCondition benchmark requirements	BioCondition benchmark score	Annually during annual reporting	The native ecosystem must achieve a BioCondition score of at least 40/80 for establishment of target vegetation and 60/80 for achievement of native ecosystem land use with a stable condition, based on benchmarks relevant to an analogous regional ecosystem, as per **Table 9-3** **AND** The monitoring of BioCondition is undertaken by an appropriately qualified person as per the latest version of the BioCondition Assessment Manual	By applying milestone criteria that refer to minimum target BioCondition scores, instead of specific benchmark targets for constituent vegetation characteristics, the criteria are achievable for developing rehabilitated ecosystems and permit variation in the local composition of these ecosystems (by using the benchmarks for the relevant regional ecosystem when calculating BioCondition at each survey site).

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
B8	Achieving milestone criteria during drought conditions	Sites fulfil criteria during drought conditions	Following a "drought" year	Sites fulfil all other milestone criteria after having experienced at least one "drought" year (defined as having a total rainfall over a 12-month period that falls within the lowest decile recorded at the nearest weather station.	Demonstrate the resilience to drought conditions.
Native ecosystems riparian					

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
C1	Land is to be stable	a) Indices of Landscape Function Analysis (Tongway and Hindley 2004). b) Depth of active rills and gullies. c) Groundcover benchmarks for different slopes d) Erosion monitoring e) Geotechnical stability f) All corrective actions where required	Sites are to be monitored at the time of planting and then every two years for 10 years after planting.	a) Landscape function analysis scores for soil stability, infiltration/runoff and nutrient cycling have started to plateau, and the plateau values predicted from sigmoidal curves fitted to the data are equivalent to or exceed values at analogue sites. b) No active rill or gully erosion deeper than 25 cm present. c) Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower then 10%; d) Erosion monitoring has been completed; e) A suitably qualified person has certified that the final landform is geotechnically stable; f) All corrective actions recommended by suitably qualified persons in response to erosion or deficient vegetation cover have been implemented;	a) This methodology has been widely applied to rehabilitated mine sites across Australia, and is strongly correlated with soil aggregate stability, soil nutrient cycling and water infiltration (Tongway and Hindley 2004). b) Provides a supplementary observational method of early erosion detection and early intervention. c) This is informed by the Reef protection regulations – Farming in Reef catchments: Grazing Guideline 2022 classification in land considered to be 'good or in fair condition for grazing'. This percentage is derived from studies indicating high rates of erosion are likely where ground cover is less than 50 percent (Roth, et al., 2004). d) This provides surety that erosion monitoring is completed. e) Confirmation that the land is stable from a geotechnical perspective ensures long term stability. f) This ensures that following the completion of erosion monitoring, management actions are undertaken to remediate any shortfalls in rehabilitation outcomes

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
C2		Percentage cover of rock, woody debris, litter, grasses and herbs within a 10 m × 50 m plot.	Late wet season (February-May), every two years for 10 years after planting.	The species richness of grasses within 10 m x 50 m plots in rehabilitated areas is to equal or exceed the 10th percentile among equivalent plots in reference sites on the same soil management unit;	A percentage cover of ≥50% protects slopes from erosion (Loch 2000; Waters 2004; Carroll *et al.* 2010). Cover ≥70% is required to achieve background rates of erosion on slopes steeper than 10% (AARC 2022). Excessive groundcover inhibits the recruitment of trees and shrubs, and a maximum value of 96% cover was observed within reference sites in stable, unmined vegetation communities (METServe 2022).
		Natural recruitment of flora species	Late wet season (February-May), every two years for 10 years after planting.	At least 50% of established species show natural recruitment;	Important for demonstrating the majority of vegetation is naturally recruited to indicate successful rehabilitation.
C3	Land is to be non-polluting	Water quality at permanent monitoring locations downstream of the Project.	Monthly, subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the Project would be reviewed and updated accordingly.	All downstream surface water quality parameters at permanent locations (**Table 9-5**) are to remain within site specific water quality monitoring limits listed in Table F3 of the approved Environmental Authority (**Table 9-7**)';	Site-specific surface water quality triggers are based on baseline surveys undertaken at the site.

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
		Groundwater quality within permanent monitoring bores	Quarterly, to demonstrate the receiving waters quality is within the trigger values for the Project. Subject to demonstrating the water quality objectives can be met, the frequency of monitoring and suite of parameters for the Project would be reviewed and updated accordingly.	Groundwater in downgradient monitoring locations remains within site-specific water quality monitoring limits as outlined in Table E1 and E2 of the Environmental Authority.	Site-specific surface water quality triggers are based on baseline surveys undertaken at the site.
		Soil quality parameters		Soil testing indicates the following parameters are met: ▪ Rootzone EC <1.5 dS/m (1,500 µS/cm), ▪ Soil pH <8.5 and >6 as measured at any part of the root zone, ▪ Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).	Topsoil criteria are required to demonstrate that land is stable, non-polluting and will sustain the PMLU

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
C4	Weeds listed under the *Biosecurity Act* are not to exceed densities typically present in unmined, grazed landscapes within the MLA and neighbouring areas.	Percentage cover within a 10 m × 50 m plot	Between February and April, every two years for 10 years after planting.	Rehabilitated areas are to have ≤0.2% cover of *Parthenium hysterophorus* **AND** rehabilitated areas are to have ≤0.1% of *Harrisia martinii* **AND** Any other weeds listed under the *Biosecurity Act* are to be present in densities of <1 individual per hectare.	Completion criteria are based on the densities of each weed recorded during ecological surveys of the region prior to mining (METServe, 2022). As weed densities vary by soil type, only data from soil types present within the MLA area are incorporated into the completion criteria.
C5	Koala food trees are to have a similar dominance within rehabilitated vegetation communities as they did in vegetation present on site prior to mining	a) With the exception of a non-permanent cover crop species, the seed mix to satisfy RM5.1 contains only those species listed in **Table 6-6** List for the relevant PMLU and reflect the regional ecosystem distribution spatially shown in **Figure 1-16**.	Sites are to be monitored six and ten years after planting.	Eucalyptus camaldulensis is to constitute 33% of the total basal area of woody vegetation in riparian PMLU; **AND** A rehabilitation performance assessment completed under RM8.4 must achieve a score of 40/80 of the reference site based on the benchmark criteria in **Table 9-3** for the native ecosystem - riparian PMLU (RE11.3.25);	Relative dominance of Koala food trees is based on secondary site data gathered from nine sand plain reference sites and three riparian reference sites (METServe, 2022). By applying milestone criteria that refer to minimum target BioCondition scores, instead of specific benchmark targets for constituent vegetation characteristics, the criteria are achievable for developing rehabilitated ecosystems and permit variation in the local composition of these ecosystems (by using the benchmarks for the relevant regional ecosystem when calculating BioCondition at each survey site).

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
C6	Achieving BioCondition benchmark requirements	BioCondition benchmark score	Annually during annual reporting	Rehabilitation areas must achieve a BioCondition score of at least 40/80 for establishment of target vegetation and 60/80 for achievement of native ecosystem land use with a stable condition, based on benchmarks relevant to the analogous regional ecosystem 11.3.25 as per **Table 9-3** **AND** The monitoring of BioCondition is undertaken by an appropriately qualified person as per the latest version of the BioCondition Assessment Manual	By applying milestone criteria that refer to minimum target BioCondition scores, instead of specific benchmark targets for constituent vegetation characteristics, the criteria are achievable for developing rehabilitated ecosystems and permit variation in the local composition of these ecosystems (by using the benchmarks for the relevant regional ecosystem when calculating BioCondition at each survey site).
C7	Achieving milestone criteria during drought conditions	Sites fulfil criteria during drought conditions	Following a "drought" year	Sites fulfil all other milestone criteria after having experienced at least one "drought" year (defined as having a total rainfall over a 12-month period that falls within the lowest decile recorded at the nearest weather station..	Demonstrate the resilience to drought conditions.
Saraji Road					

ID	Rehabilitation Objective	Rehabilitation Indicator	Assessment Timing	Completion Criteria	Justification
D1	Design and construction in accordance with agreed conditions.	Isaac Regional Council (IRC) assessment.	At the completion of all works within the realigned road reserve.	Fulfilment of all conditions of an agreement with IRC for the construction and commissioning of Saraji Road.	The Saraji Road realignment will be undertaken during the operational phase of the Project, and comprises infrastructure to remain on site after the Project is completed. As such, there are no specific rehabilitation requirements other than to construct and commission the realigned road infrastructure in accordance with conditions specified in an agreement between Vitrinite and IRC.

6 REHABILITATION METHODOLOGY

6.1 infrastructure decommissioning and removal

6.1.1 Infrastructure to be decommissioned

Most infrastructure within the project area, including ancillary infrastructure (ROM pad, offices, fuel storage, haul roads and highwall benches), CHPP, Rail loop and TLO will be removed, de-contaminated, rehabilitated and decommissioned to comply with PMLU milestones.

All infrastructure related waste material, such as concrete, bitumen, tyres and fencing will be demolished/removed and disposed of offsite.

Services, such as water and electricity will also be disconnected and terminated prior to post-closure to comply with RM1.

As part of the final landform, no final voids are proposed and all open cut pits will be backfilled with overburden material and drainage structures will be implemented on and around the final landform to ensure that the landform is free draining. When sediment dam catchments and MAW dams are completely rehabilitated, and water quality monitoring of the runoff has established that it is consistent with natural background conditions, the sediment dam and associated drainage infrastructure will be decommissioned.

In times when there is heavy rainfall, the plunges will accommodate the MAW runoff. When there is no runoff (or need for storage), then the plunges can be barricaded as the mining progresses along the bench.

In the highwall mining area, completed plunges will be either filled with MAW (as per **Appendix A**) and barricaded or just barricaded and rehabilitation will occur around this.

Diversions will be decommissioned and rehabilitated to comply with PMLU milestone requirements. Existing conditions natural topography will be reinstated within the Hughes Creek floodplain as well as Drainage line 6 and Drainage line 8 Post-closure to replicate the existing drainage line channels to minimise the impacts associated with the Post-closure Conditions landform. Drainage line 1 is proposed to be diverted and subsequently reinstated as part of the Project. The Hughes Creek floodplain will be reinstated through the Vulcan Main and Vulcan South landforms (**Appendix A**).

6.1.2 Infrastructure to be retained

Infrastructure that is beneficial to the landholder, pending a written agreement between Vitrinite and the post-mining land holder, will be retained. This may include specific water infrastructure for stock watering purposes.

The railway line along the eastern edge of the ML existed prior to mining and will remain unaffected.

6.2 Landform Design

6.2.1 Overview

The final landform has been designed to limit the size of the Project's final footprint while maximising usage of areas already disturbed for the open-cut pits. No final voids are proposed as part of the final landform. The open-cut pits will be backfilled with waste rock material. Due to waste rock swell factors following blasting and handling, the Vulcan North, Main and South in-pit waste rock dumps will fill the void and extend approximately 5 m, 40 m and 20m, respectively, above the pit crests. These in-pit waste rock dumps take the shape of low plateaus. Outer batters will be shaped to 1(V):6(H) (15%) and will contain surface water management measures to drain water from the plateau to the surface water drainage features in the surrounding landscape. Contour banks will be constructed on batters to limit topsoil erosion until vegetation has been suitably established. Refer to the LEM – **Appendix F** for the Vulcan South in-pit WRD dimensions.

The ex-pit waste rock dumps will be approximately 40 metres high (Geotechnical assessment – Appendix G) and have batter slopes of up to 250 m for the Vulcan North ex-pit WRD, 220 m for the Vulcan Main ex-pit WRD and 210 m for the Vulcan South ex-pit WRD (**Appendix F**). Refer to **Appendix F** (LEM) for ex-pit WRD dimensions.

The pits will be backfilled progressively, utilising a combination of paddock dump and end-tipping techniques. Dump lifts are generally anticipated to be low, enhancing rapid material settlement. Placed waste shaping and profiling will be completed with bulldozers. Final landform geometry will be surveyed progressively to maintain adherence to the final landform and surface water management design. In-pit waste rock dumps will have a cover that facilitates plant establishment. Sub-soil, rock mulch and topsoil will be spread with bulldozers and will be the subject of depth and distribution survey and quality control monitoring, as detailed in **Section 9**. PAF materials will be placed in the central core of the WRD and encapsulated with at least 5 m of NAF waste rock material.

All other mining activities will result in limited change to the pre-mining topography and hence all areas excluding the in-pit dumps and the ex-pit dumps will resemble the pre-mining landform. To achieve this, minor shaping or reprofiling works will be undertaken once infrastructure has been removed and any contamination remediated, in order to smooth the ground surface and merge the landform into the surrounding natural contours.

The final landforms for Vulcan North, Vulcan Main and Vulcan South are depicted in **Figure 6-1**, **Figure 6-2**, and **Figure 6-3** respectively.

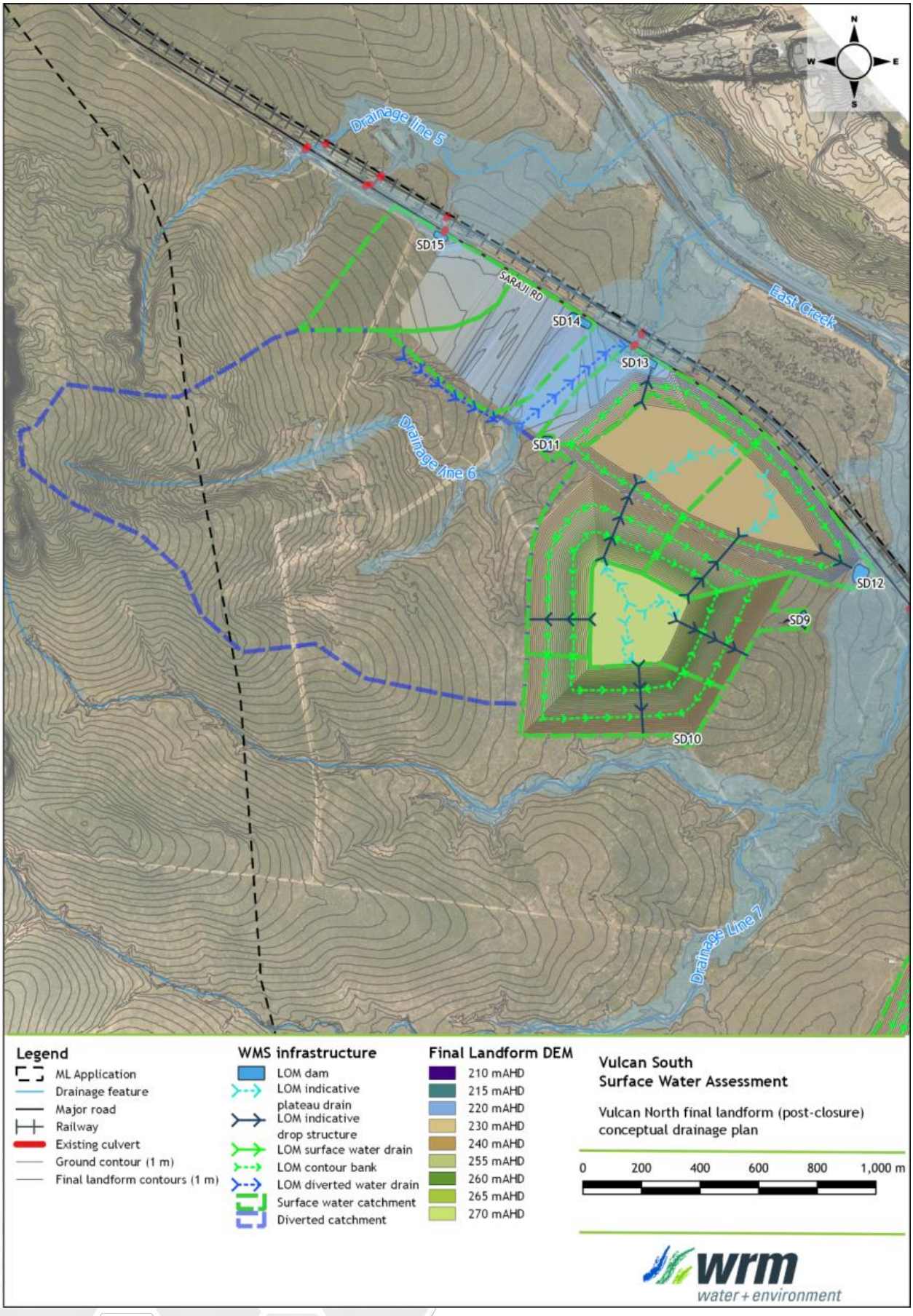


Figure 6-1 *Vulcan North Final Landform*

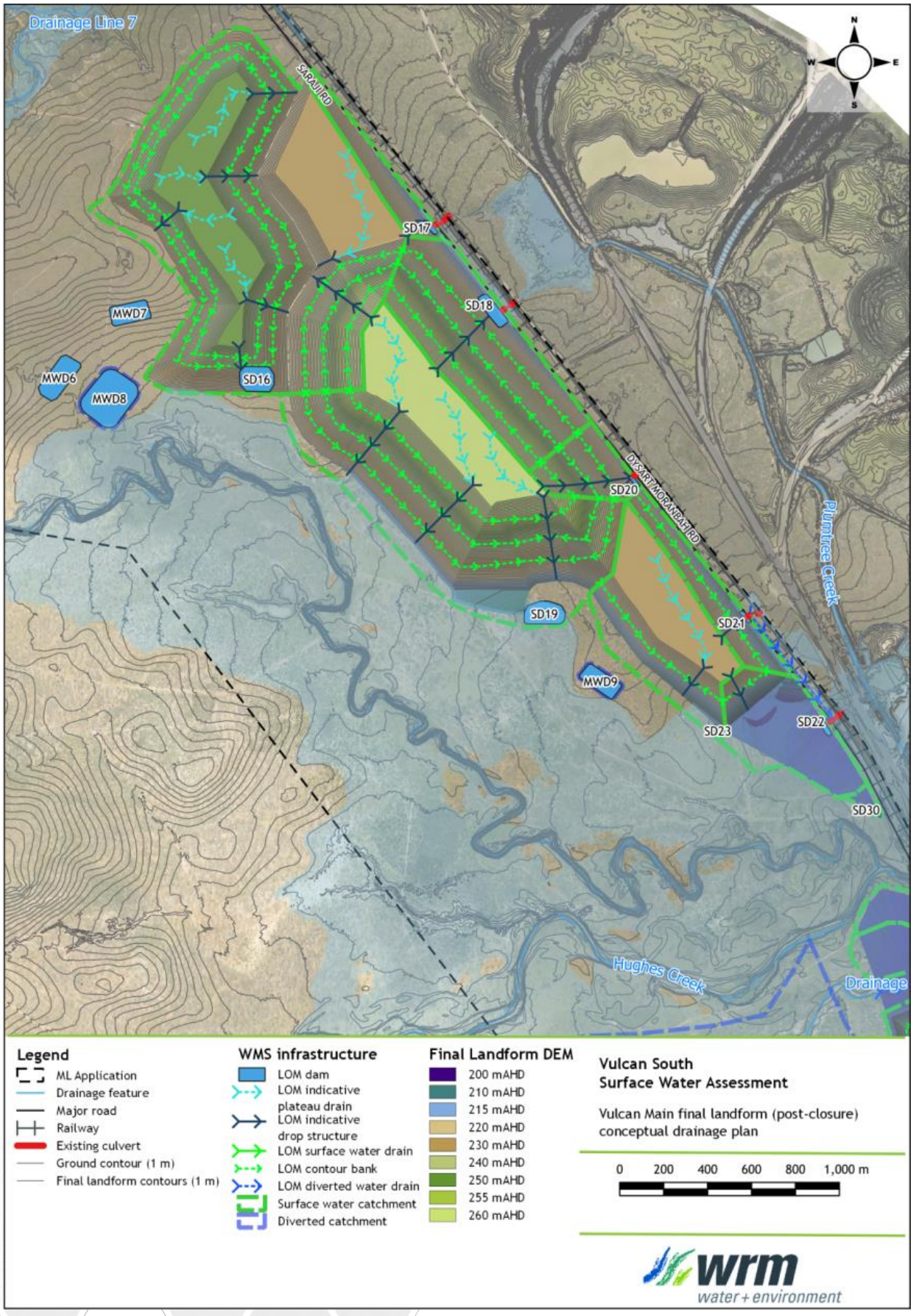


Figure 6-2 Vulcan Main Final Landform

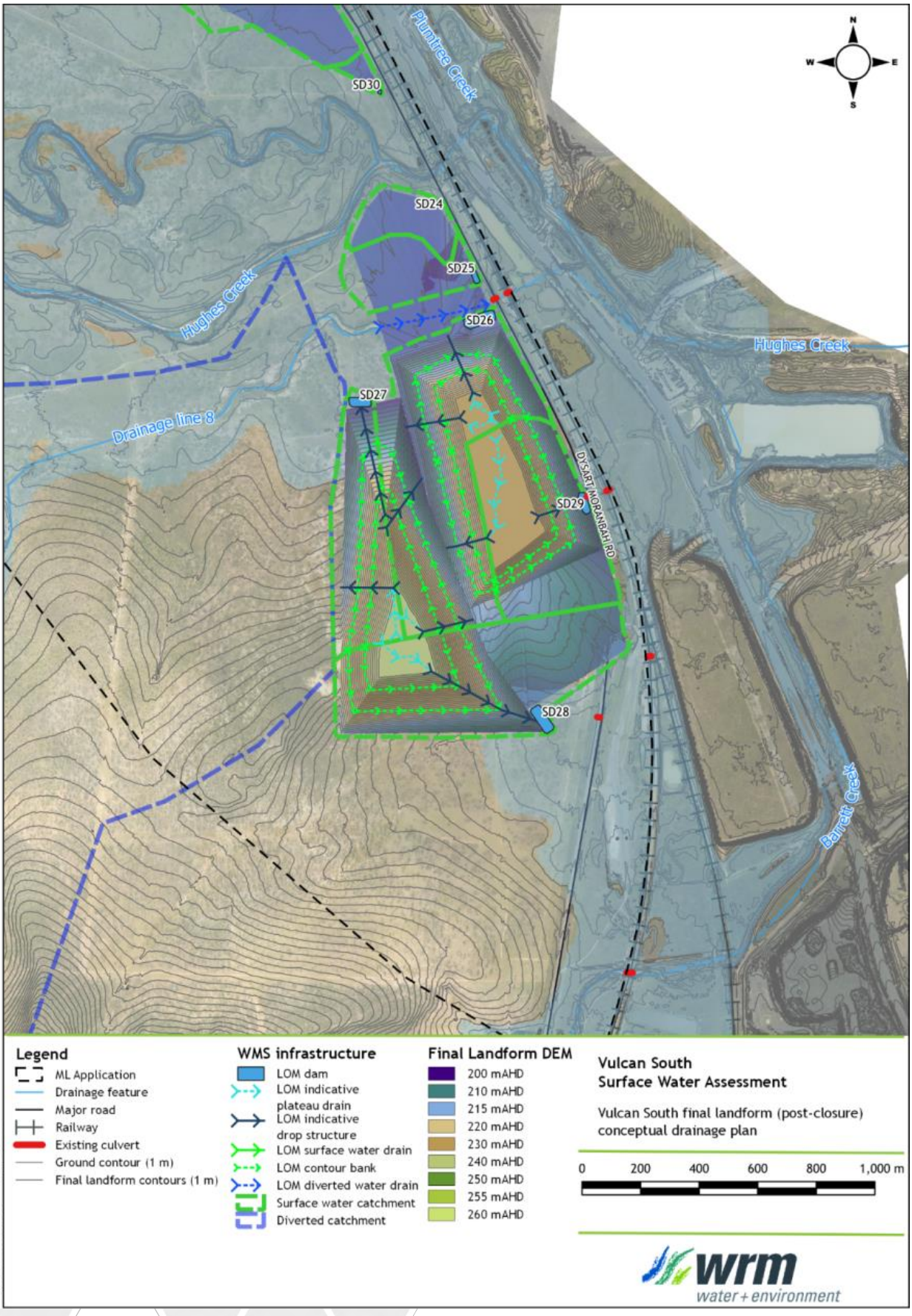


Figure 6-3 Vulcan South Final Landform

6.2.2 Design Assumptions and Limitations

The design of the final landform was based on the following limitations and assumptions:

- the footprints of the in-pit dumps are constrained by the boundaries of the pit, which is itself constrained by coal availability and the easement of Saraji Road along the eastern boundary of the MLA area. For logistic reasons, dumped waste rock will have steeper batters than 15%, which are later recontoured to a 15% slope, resulting in a final landform that extends slightly beyond the original boundaries of the pit;
- the footprints of the ex-pit dumps are constrained by surrounding flood plains, adjoining mine infrastructure and the MLA area boundary;
- batters shaped up to a maximum slope of 15 %.in order to produce a final landform, maximum elevations of 260 m, 250 m and 240 m (reduced level -RL) were selected for the Vulcan North, Main and South ex-pit dumps, respectively, to closely match the pre-mining and adjacent topography;
- the height of in-pit dumps is determined by the volume of waste rock to be removed during mining and the amount that can be stored in the ex-pit dumps given the above constraints in height and footprint;
- final landform designs for the in-pit dumps have considered the dump heights to closely match the hills in the nearby Harrow Range. The in-pit dumps will extend up to approximately 60 m above the surrounding ground level
- a swell factor of 25% has been assumed for waste rock material calculations of dump heights. This swell factor is typically what is observed elsewhere in the Bowen Basin;
- for stability reasons, a maximum slope of 15% was used on the final landforms (based on assessments by AARC 2022 and Blackrock Mining Solutions 2022: summarised in **Section 6.1.8** of this PRC Plan) and, where possible, this was reduced further;
- drainage structures were incorporated into the design of the final landform to further improve long-term stability. Drainage designs were based on recommendations and assessments by WRM (2022) and have been engineered so that catchment boundaries and flows are as similar as practicable to the pre-mining state; and
- the plateau formed by the in-pit dumps have a 1% slope to the west, so that surface water is directed away from Saraji Road and into existing drainage systems.

6.2.3 Mine Waste Geochemistry

A geochemical assessment has been undertaken of the waste rock and coal rejects (RGS, 2022) (**Appendix H**). This found that waste rock at the Project had a universally low sulphide content and high acid-neutralising capacity due to high pH. Most of the coal reject materials represented by the samples tested have relatively low sulfide content, excess ANC, and are classified as NAF. All carbonaceous interburden samples within the MLA were classified as non-acid-forming and, as a mixed bulk material, carbonaceous interburden is considered to be non-acid-forming.

An analysis of the concentrations of 22 metals and metalloids (and four other trace elements) within waste rock revealed that no samples were relatively enriched, compared to the mean crustal abundance of each element (RGS, 2022). The potential solubility of any metals/metalloids in the materials was investigated further through water extract and kinetic leach column tests. Most metal/metalloid concentrations tested in the water extracts were below the applied water quality guideline criteria. The main exceptions were aluminium (four/10 samples) and copper (three/10 samples), which had a concentration in some of the water extracts above the applied freshwater aquatic ecosystem water quality guideline value for 95% species protection (ANZG 2018), but below the applied guideline values for livestock drinking water. Based on these results, the risk of potential impact on the quality of surface runoff and groundwater from bulk mining waste materials at the Project is low. The results of the kinetic leach column tests supported the results of the water extracts; namely, that the concentration of metals/metalloids in the leachate was low and typically below the laboratory limit of reporting. The concentrations of all metals/metalloids were below the applied water quality guideline criteria for aquatic freshwater ecosystems (95% species protection level) (ANZG 2018).

Like the waste rock material, the coal reject material had a mean acid-neutralising capacity that far exceeded (more than twice) the maximum potential acidity. However, there was variability between samples, such that one sample (out of 11) was classified as "potentially acid-forming", and a further three samples were classified as "uncertain". As a bulk mixed material, coal reject has a relatively low risk of generating acidic drainage. This risk can be further lessened by disposing reject materials within cells contained within waste rock dumps that have a very high acid-neutralising capacity. As for waste rock, leachate from coal reject samples did not have elevated metal concentrations during kinetic leach column tests. All processing wastes, including reject material and dry tailings, will be stored within waste rock dumps (primarily the in-pit dumps), removing the requirement for a tailings storage facility at the site. Priority will be given to disposing processing wastes within in-pit dumps at depth; however, scheduling constraints may necessitate storage of some material in out-of-pit waste rock dumps.

The in-pit disposal of mixed coarse and fine reject materials within waste rock cells is also a low risk strategy as the much larger volume of waste rock typically has very low sulphur content and excess acid-neutralising capacity. This mining waste management strategy is currently used at a number of coal mines in the Bowen Basin (RGS, 2022).

Overall, surface runoff and seepage from the waste rock material is expected to be pH neutral to slightly alkaline and have a low level of salinity. Dissolved metal and metalloid concentrations in surface runoff and leachate from bulk mining waste materials are expected to be low and unlikely to pose a significant risk to the quality of surface and groundwater resources.

6.2.4 Cover Design

Geochemical characterisation of waste rock has demonstrated that with a co-disposal strategy of rejects and waste rock at depth, there is a minimal potential for acid mine drainage, neutral metalliferous mine drainage or saline mine drainage (RGS, 2022) (**Appendix H**). Due to the benign nature of all waste rock material on site, low-permeability (air and water) cover systems are not required or proposed.

Rather than being designed to limit permeability, the proposed cover has been designed to facilitate vegetation re-establishment on waste rock. Following the return of waste rock to the mined pit, at least 300 mm of subsoil (removed from the pits prior to mining and stockpiled) will be spread over the waste rock (**Figure 6-4**). This will enhance the water-holding capacity of the soil and provide a more favourable growing environment for vegetation. Given the vulnerability of local subsoils to dispersion, some waste rock will be mixed with the subsoil (approximate ratio of rock to subsoil of 1:3), to provide protection from erosion, in the unexpected event that that rock mulch cover and developing grass cover doesn't provide adequate protection, and the overlying topsoil becomes eroded in places. Where required, 30% cover of rock mulch will be applied to 10-15% gradients will be more than adequate for maintaining stability until vegetation establishes.

Topsoil will be spread over the subsoil/rock mix to a depth of 0.25 m to provide a favourable medium for plant establishment. Note that this cover design varies slightly between rehabilitation areas due to rehabilitation requirements (**Table 6-1**).

In addition, a number of topsoil and subsoil ameliorative measures will be implemented, where required, to ameliorate poor soil structure, low moisture retention and low nutrient concentrations that may be encountered with the Limpopo SMU (**Section 1.2.7**). Such amelioration measures may include the application of organic matter, fertiliser, rapid establishing cover crops, and hydro mulching. More specific detail on the application of these measures is provided in **Section 6.3.4 to 6.3.7.**

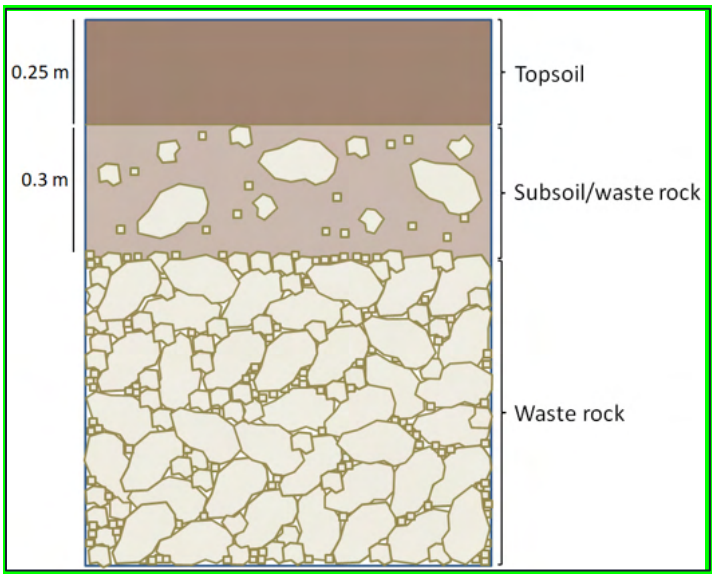


Figure 6-4 Cover design to optimise plant growth

There is strong evidence to support the suitability of the proposed cover design for plant establishment:

- Many independent studies across north-eastern Australia have found that 75-95% of total root biomass within open eucalypt forests and woodlands is contained in the upper 0.5 m of the soil profile (Eamus *et al.* 2002; Zerihun et al. 2006; Grant *et al.* 2012), so a soil depth of 55 cm is expected to be suitable for supporting tree growth.
- The cover design is similar to the natural soil profile on the Crocodile soil management unit, which has an average soil depth of 0.62 m above rock (see **Section 1.2.7**) and supports a dense cover of native vegetation.
- Trials undertaken at the adjacent Saraji Mine compared vegetation establishment on waste rock (spoil) that received 0 cm, 10 cm or 30 cm of topsoil prior to planting (Kopittke *et al.* 2004). Grass established at higher densities in the topsoil treatments than on the spoil; however, even on spoil, grass achieved 70% cover. Native trees and shrubs actually established better without topsoil, due to reduced competition with grass, but natural thinning over the first ten years resulted in a final stem density that was equivalent to the topsoil treatments. The spoil at Saraji is more saline (Kopittke *et al.* 2004) than that at Vulcan South, suggesting that local waste rock is unlikely to pose a barrier to root growth for local vegetation. Based on these trials, the cover proposed at the Project is expected to be ideal for establishing a productive pasture with a moderate density of native woody vegetation.

RA10 (the highwall mining area) is located within the Crocodile SMU. This SMU has a topsoil layer most often only reaching 0.06-0.08m (6-8cm) and subsoil reaching 50cm; however, often each of the horizons blend into one another with no visible differentiation and frequent interspersion with coarse rock fragments throughout. Because the topsoil only reaches approximately 6-8cm below surface level, it is not possible to extract 30cm of topsoil (as proposed for other rehabilitation areas).

For this reason, a unique cover design and strategy is required for RA10. Available topsoil will be extracted from the highwall mining area and mixed with crushed rock (from the rock located with the highwall mining area) to create a total depth of topsoil/crushed rock of 0.25 m, which is in line with the topsoil depth of areas outside of the highwall mining area (**Figure 6-5**). As discussed above, elaborated to below and discussed further in **Section 6.2.8**, crushed rock mixed with topsoil has numerous benefits to plant growth and erosion control.

The use of rock to act as a medium for plant growth, in addition to its use as a soil stabiliser to reduce erosion has been well studied (Poesen & Lavee, 1994; Simanton & Toy, 1994; Zhang, et al., 2016). Rock fragments have a complex influence on soil hydrological processes (e.g. soil erosion, runoff generation, water infiltration, solute transport and water flow) and are essential in the relationship between soil and plant growth success (Zhang, et al., 2016). With moderated temperatures, soils under rock fragments often have microclimatic conditions that

favour increases in the activity of soil biota, which affect soil hydrological processes. Rock fragments, in particular those resting on the soil surface, are important in affecting soil hydrological processes by (i) protecting topsoil from detachment and the impact of raindrops; (ii) reducing physical degradation of the soil surface; and (iii) slowing the rate of runoff generation (Poesen & Lavee, 1994).

There are also benefits to plant growth and establishment through the use of crushed rock in areas with a limited soil profile (Hu, Li, McCormack, & Huang, 2021). Studies regarding the effect of rock fragments on plant performance consider root foraging behaviour (Hu, Li, McCormack, & Huang, 2021), biomass allocation, root vertical distribution (Hu, Li, McCormack, & Huang, 2021), and productivity in different plant species.

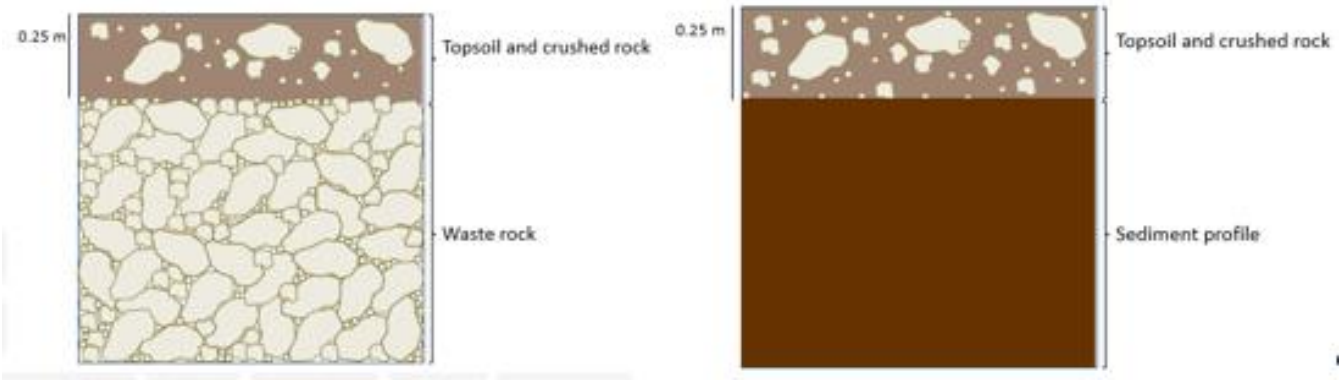


Figure 6-5 Highwall mining area cover design strategy for ex-pit WRD (left) and remaining areas (right)

Table 6-1 Cover variations in each rehabilitation area

Rehabilitation Area	Deviation from standard cover design	Justification
RA1: North and South ex-pit dump	Design as shown in Figure 6-4	N/A
RA2: Main ex-pit dump	Design as shown in Figure 6-4	N/A
RA3: Reinstated watercourse	Land is to be reformed prior to the deposition of subsoil and topsoil. No waste rock is to be added.	The landscape is to emulate the previous condition
RA4: North and South in-pit Dump	Design as shown in Figure 6-4	N/A
RA5: Main in-pit Dump	Design as shown in Figure 6-4	N/A
RA6 Infrastructure areas – previously wooded	Topsoil is to be placed directly onto prepared disturbed surfaces.	Apart from the rail loop, where deeper incisions may be required for cuttings, no waste rock or subsoil is to be removed from infrastructure areas and therefore these remain intact. For the rail loop, subsoils will be replaced during the backfilling of any excavations, to resemble conditions prior to subsoil removal.
RA7 Infrastructure areas – previously cleared	Topsoil is to be placed directly onto prepared disturbed surfaces.	Apart from the rail loop, where deeper incisions may be required for cuttings, no waste rock or subsoil is to be removed from infrastructure areas and therefore these remain intact. For the rail loop, subsoils will be replaced during the backfilling of any excavations, to resemble conditions prior to subsoil removal.
RA8 Water management infrastructure in previously wooded areas	Land is to be reformed prior to the deposition of topsoil. No waste rock or subsoil is added, beyond what is already contained within the dam walls.	There is to be minimal disturbance to the soil profile at dams once reforming has been conducted and topsoil returned.
RA9 Water management infrastructure in previously cleared areas (haul roads)	Land is to be reformed prior to the deposition of topsoil. No waste rock or subsoil is added, beyond what is already contained within the dam walls.	There is to be minimal disturbance to the soil profile at dams once reforming has been conducted and topsoil returned.
RA10 Highwall mining area	Ex-pit WRD: Topsoil/crushed rock is to be placed directly on waste rock without an intermediate layer of subsoil. Highwall plunges: the completed plunges will be barricaded or alternatively filled with MAW as a storage area and then barricaded.	The topsoil in this area is limited and therefore is to be mixed with crushed rock to a level of 0.25 m to allow for enough plant growth medium. The topsoil in this area is limited and therefore is to be mixed with crushed rock to a level of 0.25 m to allow for enough plant growth medium. Highwall plunges: This methodology will provide an option for the control of MAW

6.2.5 Material Availability

All materials (i.e., topsoils and subsoils) to be used for rehabilitating disturbed land will be sourced from the disturbance footprint and stockpiled during the mining process, until required for rehabilitation. Given that the post-mine landform will be similar but not identical to the pre-mine landform, discrepancies are likely between the quantities of materials obtained from each area and the quantities required to be returned.

As described in Section 6.2.3 and **Appendix C**, only 2/8 SMUs (Crocodile and Kei) contain viable subsoil to be used in rehabilitation without the need for additives. This means that subsoil collected from other SMUs will need to be mixed with materials such as gypsum before being used for rehabilitation. **Table 6-2** was calculated using the

rehabilitation soil profile plan as described in **Section 6.1.3**, where 30 cm of the soil profile is removed prior to mining.

As can be seen by the materials balance shown in **Table 6-2**, any discrepancies caused by alterations to the landform are expected to be balanced by (a) replacing a slightly thinner layer of topsoil than removed and (b) mixing rock with subsoils. Ample remaining material is available as a contingency. Where additional topsoil or viable subsoil material is available, more will be placed as required. Assumptions for the material balance are that 30 cm of topsoil and subsoil will be stripped and 0.25 m will be placed back for rehabilitation in all areas except RA10 (where 0.15m of topsoil will be stripped and 0.15 m will be returned and mixed with crushed rock).

Table 6-2 Materials balance for topsoils and subsoils to be used for rehabilitation

Material	Amount removed from disturbance footprint available for application (m^3)	Amount required for rehabilitation (m^3)	Balance (m^3)
Topsoil*	3,943,950	3,353,150	590,800
Subsoil†	1,913,700	1,435,275	478,425
Waste rock	282,248,294 tonnes	496,575 tonnes	281,751,719 tonnes

*The top 0.30 m of topsoil is removed from most disturbed areas prior to mining, while 0.25 m of topsoil is returned to all rehabilitated areas
"This calculation assumes that subsoil is only removed for RA1, RA2, RA3, RA4, RA5, RA8 and RA9. RA6 and RA7 refer to infrastructure and water infrastructure areas which will not require subsoil layers rehabilitated as they will remain intact. There is no subsoil in RA10.
*The top 0.30 m of topsoil is removed from most disturbed areas prior to mining, while 0.25 m is returned.
The exception to this is RA10 of the highwall mining area, where there is naturally no subsoil and topsoil is limited. For this reason, available topsoil will be stripped and combined with crushed rock to make up a 0.25 m depth of growth medium.
†The top 0.30 m of subsoil is removed from some disturbed areas (RA1, RA2, RA3 , RA4, RA5, RA8 and RA9) prior to mining, and three parts of this is diluted with one part rock when returned to rehabilitated areas.
A 0.30 m layer of subsoil is required for rehabilitation, with the layer consisting of 0.075 m of waste rock and 0.225 m of subsoil – a 1:3 ratio of waste rock to subsoil.

Drilling conducted by Vitrinite has identified medium to high-strength sandstone resources both above and between coal seams that are likely to be suitable for use in rock mulching. Based on geological modelling, this resource is expected to be abundant far beyond the requirements for landform construction.

The geochemical and geophysical characteristics of waste rock will be assessed to identify the suitable strata for use in landform stabilisation. Once these strata are confirmed, mine scheduling and selective handling will be applied to ensure that suitable material is available for the progressive rehabilitation of landforms. Further information on waste rock testing is provided in **Section 6.3.8.**

6.2.6 Surface Water

A mine site water management system will be implemented throughout the operational and rehabilitation phases of the Project to mitigate the potential impacts on surface water resources. A surface water monitoring program will be implemented to monitor potential environmental impacts and ensure that the site water management system is meeting its objectives.

Final Landform Drainage

The conceptual final landform drainage is provided in **Appendix A**. This presents the proposed drainage principles to be implemented on the final landform. The drainage plan has been developed with the aim of retaining certain water infrastructure constructed during operations, for the management of surface waters in closure. Pending the requirements of the post-closure landholder and a formal written agreement between Vitrinite and the landholder some sediment dams may be retained for the purposes of stock watering. Otherwise, troughs or other water related infrastructure will be installed for the purposes of stock watering, as part of RM6.

The landform is intended to be free-draining and to discharge to the receiving environment water of a similar quality to surrounding background sites. **Figure 6-6** depicts the final landform and key drainage features of Vulcan North post-closure and the marked cross sections (XS-1 and XS-2) are illustrated in **Figure 6-7. Figure 6-8** depicts the final landform and key drainage features of Vulcan Main and the marked cross sections (XS-3 and XS-4) are illustrated in **Figure 6-9, Figure 6-10** and **Figure 6-11**. **Figure 6-12** depicts the final landform and key drainage features of Vulcan South and the marked cross sections (XS-5, XS-6) are illustrated in **Figure 6-13.**

The following structures are proposed to comply with the site water management system:

- diverted water drains, bunds and drainage diversions to divert runoff from undisturbed catchments around areas disturbed by mining;
- flood protection levees along the southern side of the Vulcan North pit extent,
- along the western and southeastern sides of the Vulcan Main pit, and around the Vulcan South pit;
- sediment dams and drains to collect and treat runoff from waste rock emplacement areas; and
- mine-affected water drains and dams to store water pumped out of the open cut mining areas and to collect runoff from the infrastructure areas.

The key features of the final landform are:

- no final voids are proposed. All open cut pits will be backfilled with waste rock material;
- drainage structures will be implemented on and around the final landform to ensure that the landform is free draining; and
- when sediment dam catchments are completely rehabilitated, and water quality monitoring of the runoff has established that it is consistent with natural background conditions, the sediment dam and associated drainage infrastructure will be decommissioned.

The conceptual final landform is not considered likely to have a long-term significant impact on the receiving waters (WRM, 2023).

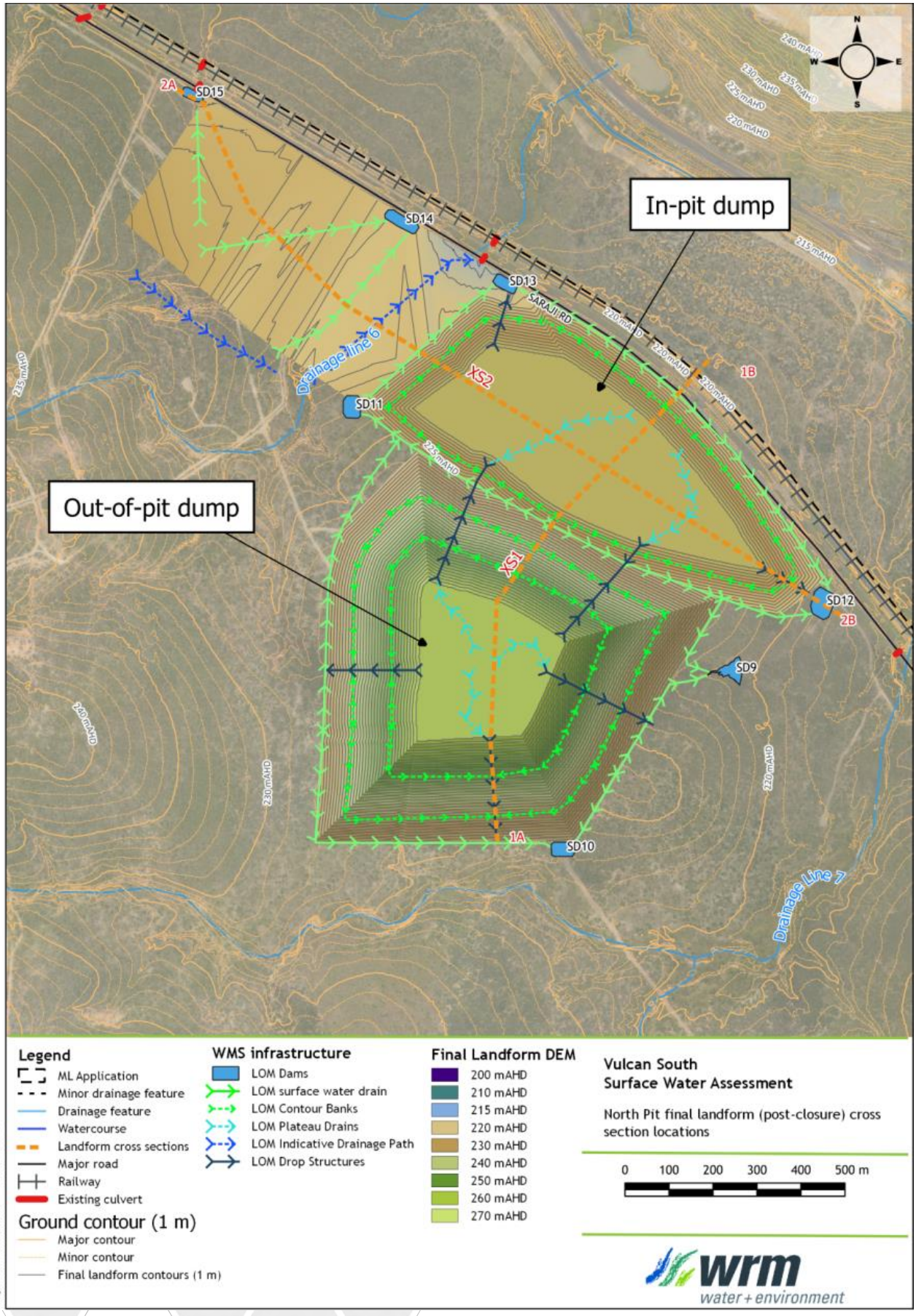


Figure 6-6 *Vulcan North Final Landform cross section locations*

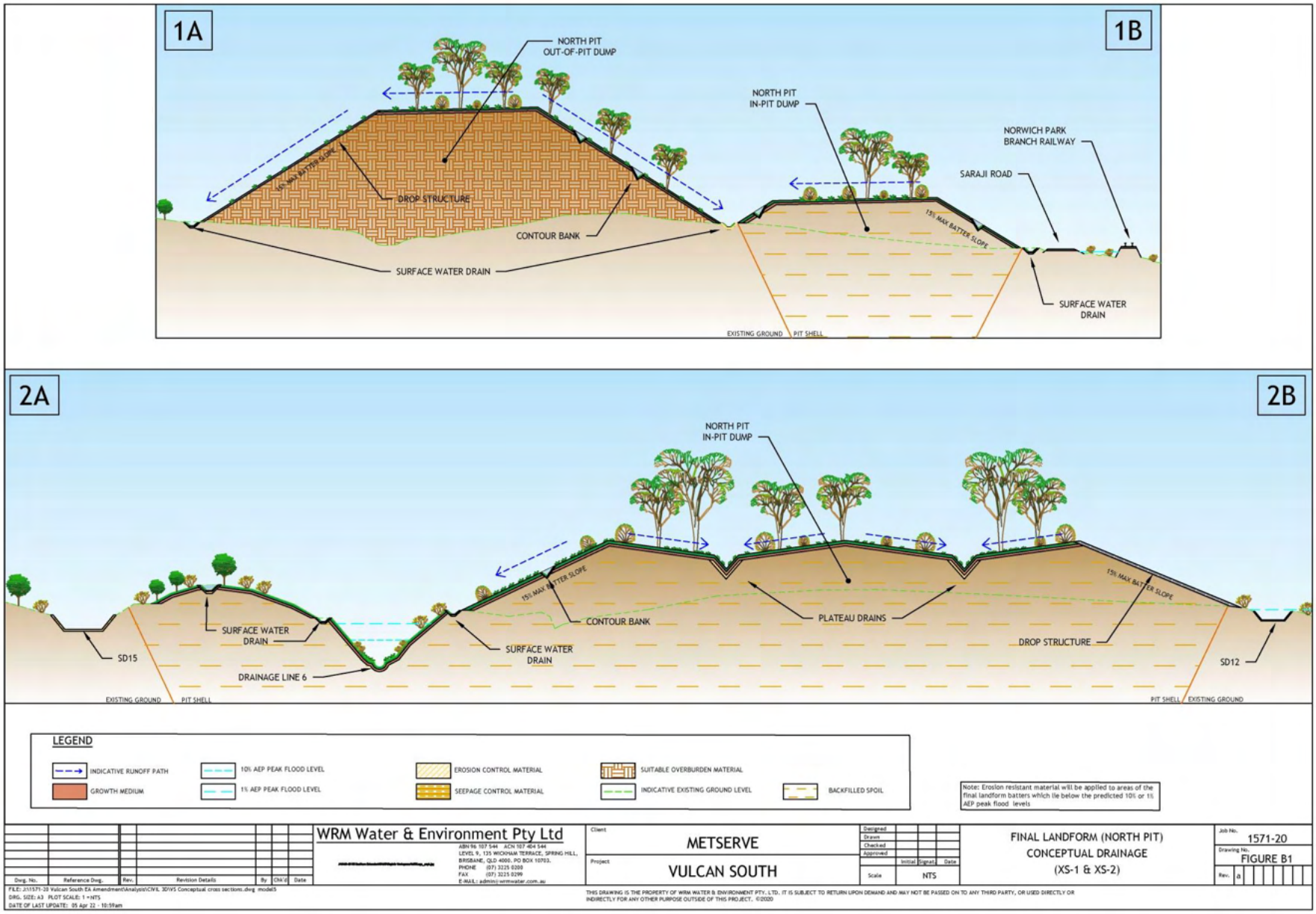


Figure 6-7 *Vulcan North Final Landform Conceptual Design (XS-1, XS-2)*

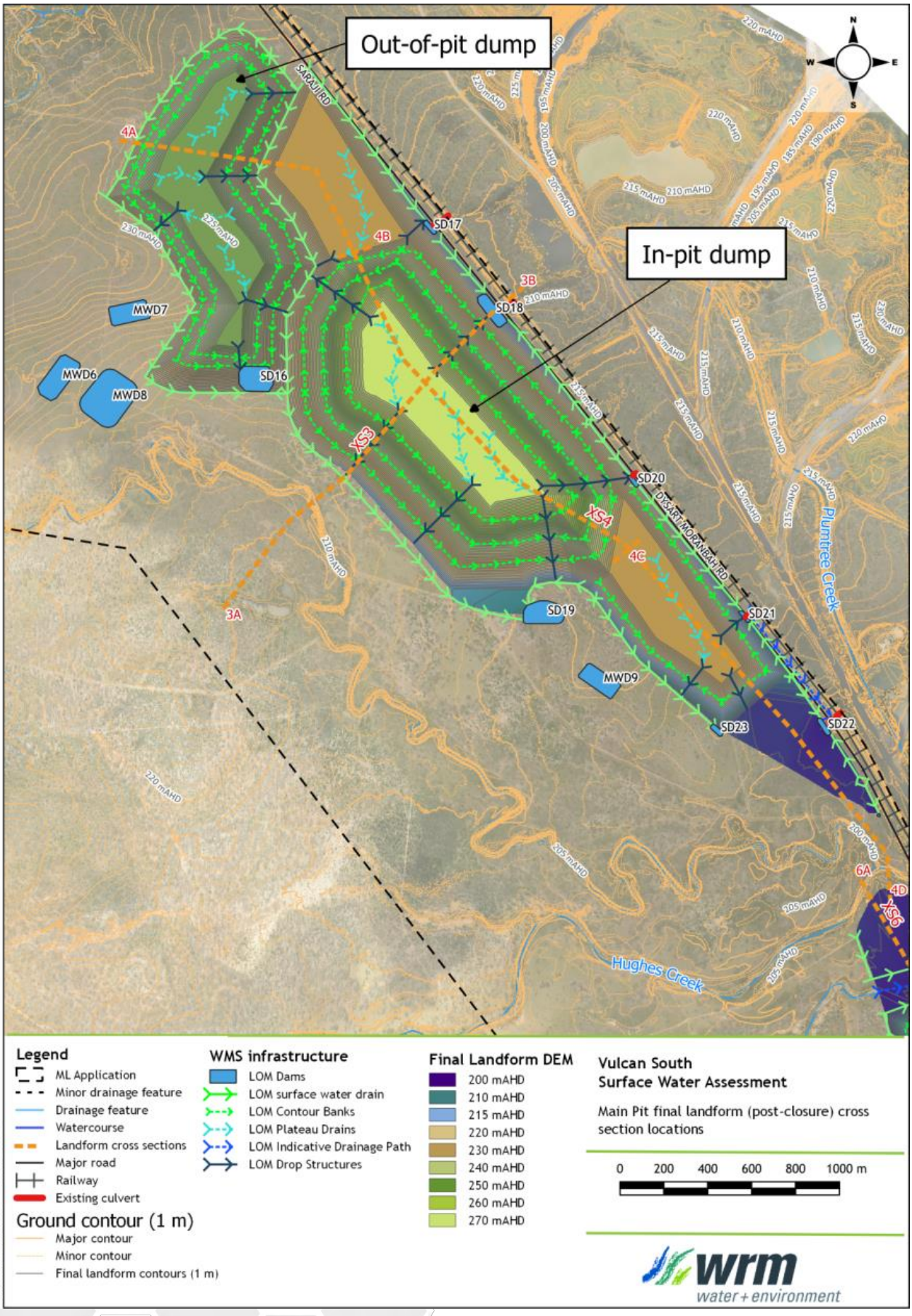


Figure 6-8 Vulcan Main Final Landform cross section locations

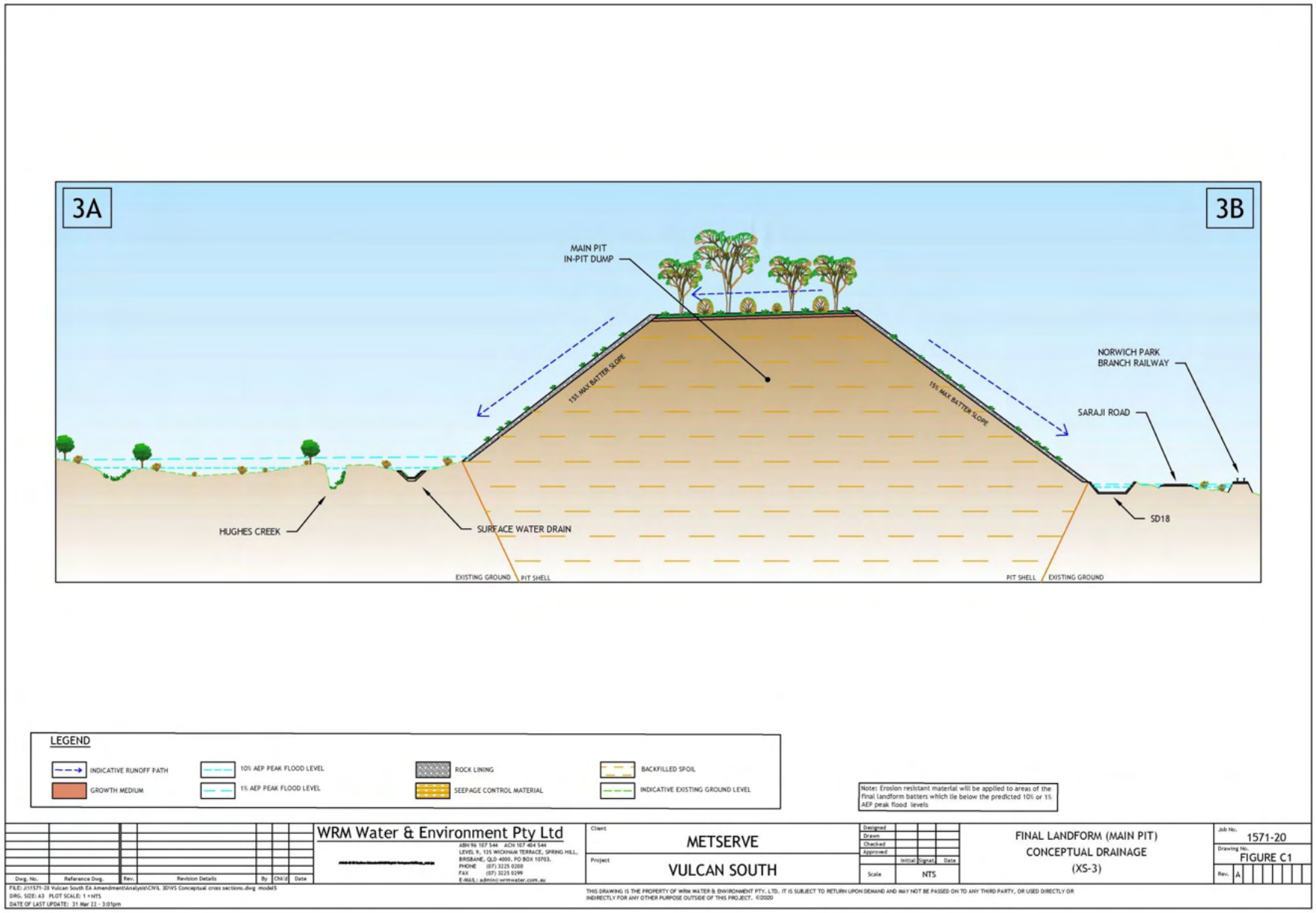


Figure 6-9 *Vulcan Main Final Landform Conceptual Design (XS-3)*

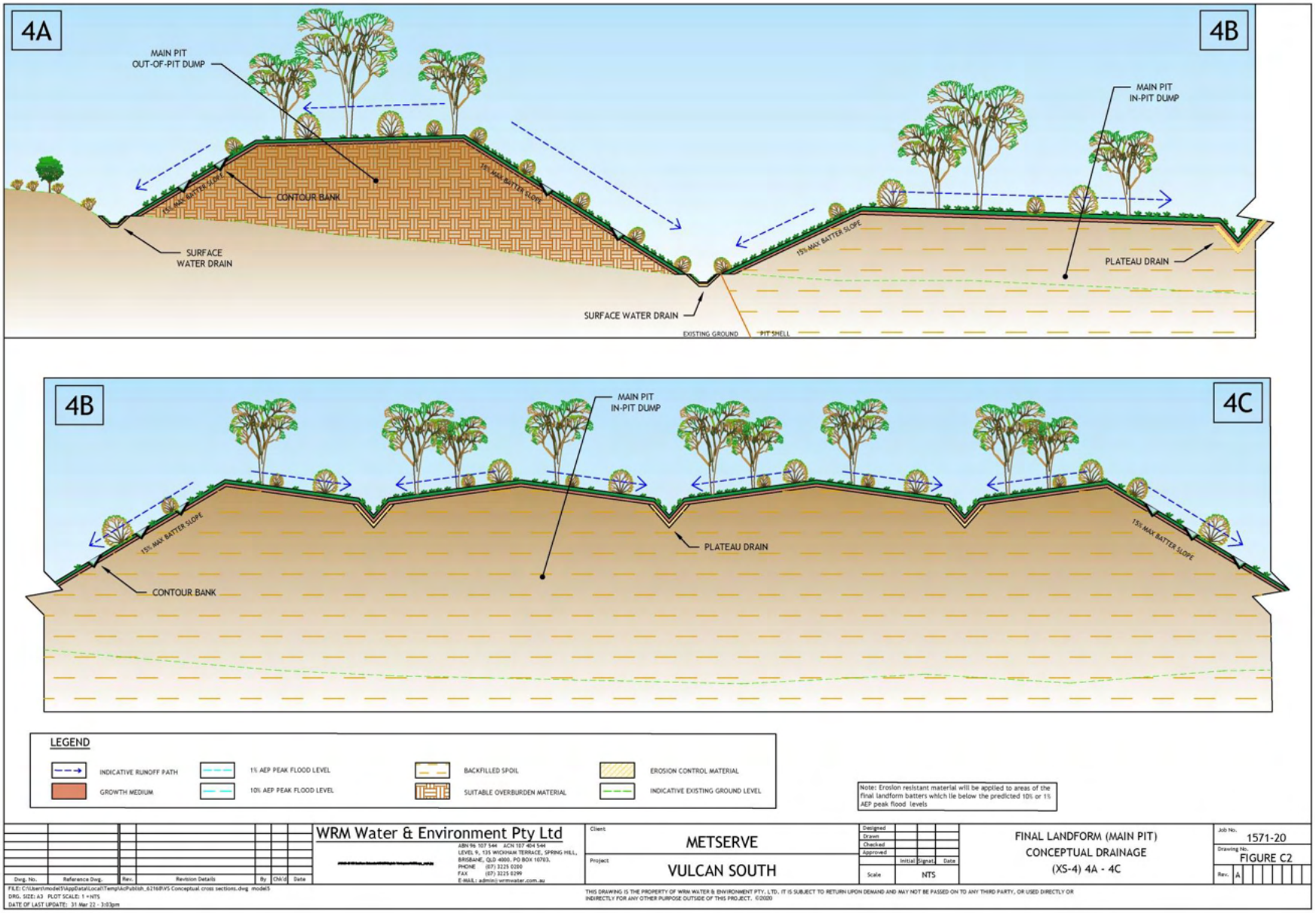


Figure 6-10 Vulcan Main Final Landform Conceptual Design (XS-4abc)

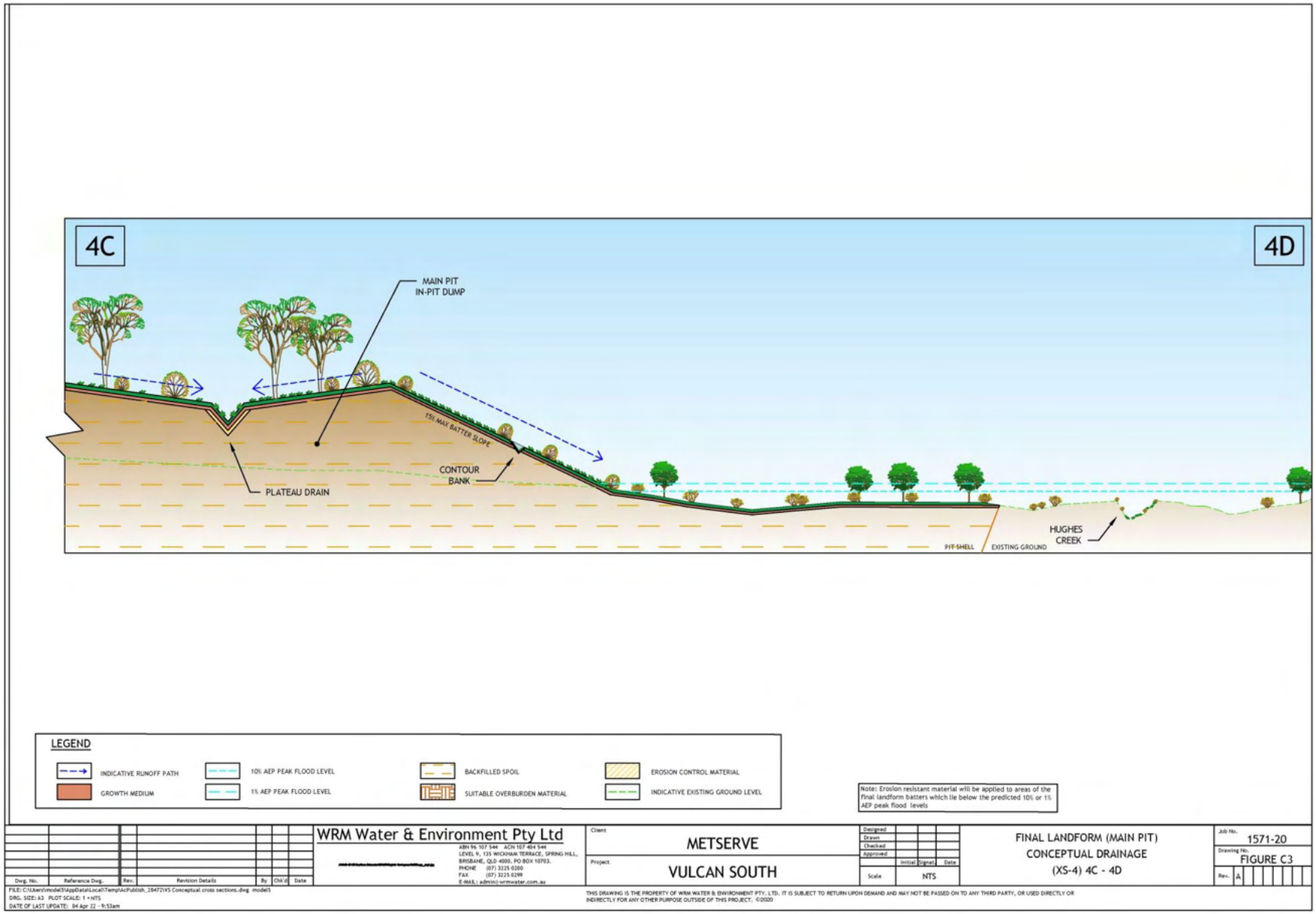


Figure 6-11 Vulcan Main Final Landform Conceptual Design (XS-4cd)

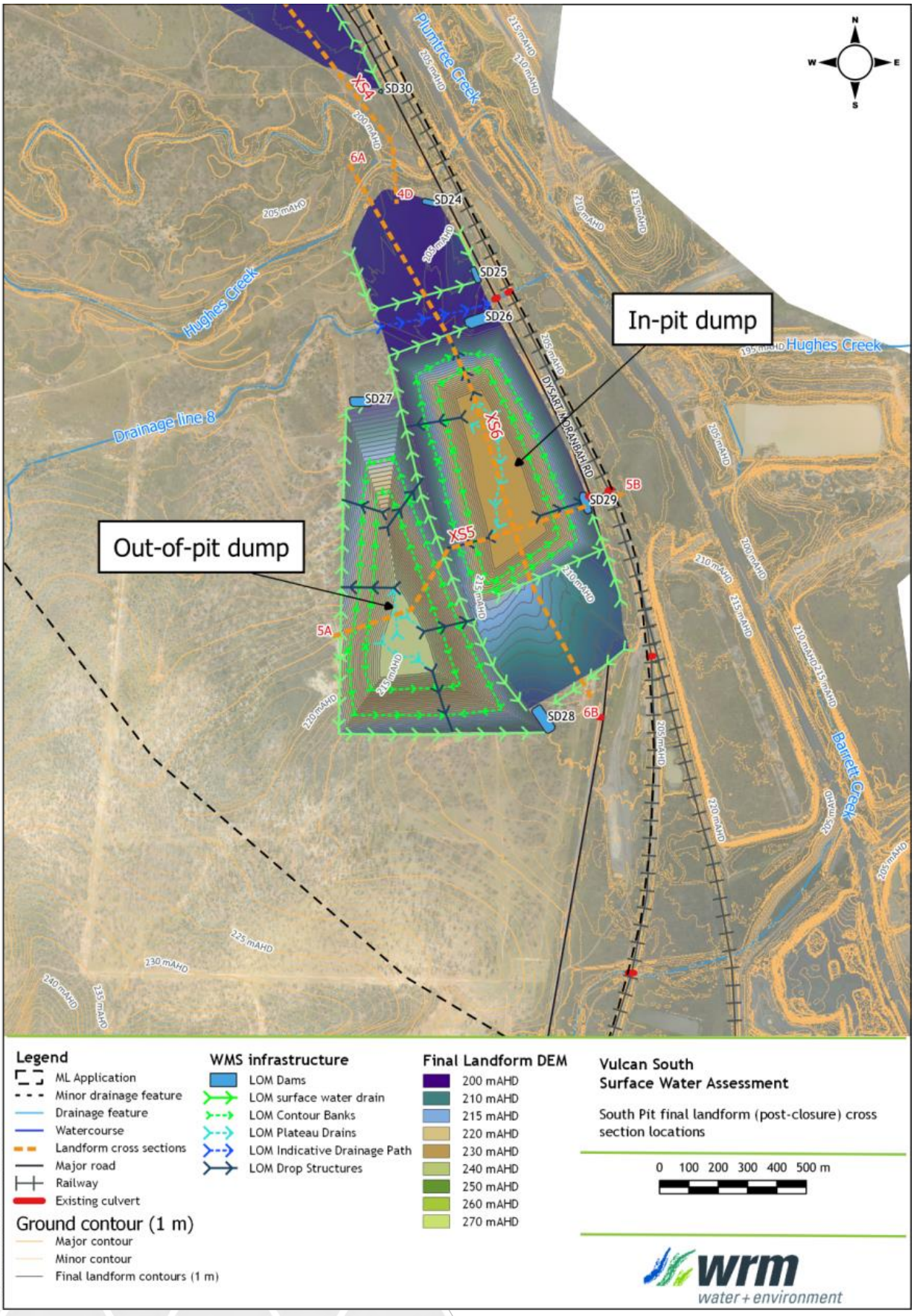


Figure 6-12 Vulcan South Final Landform cross section locations

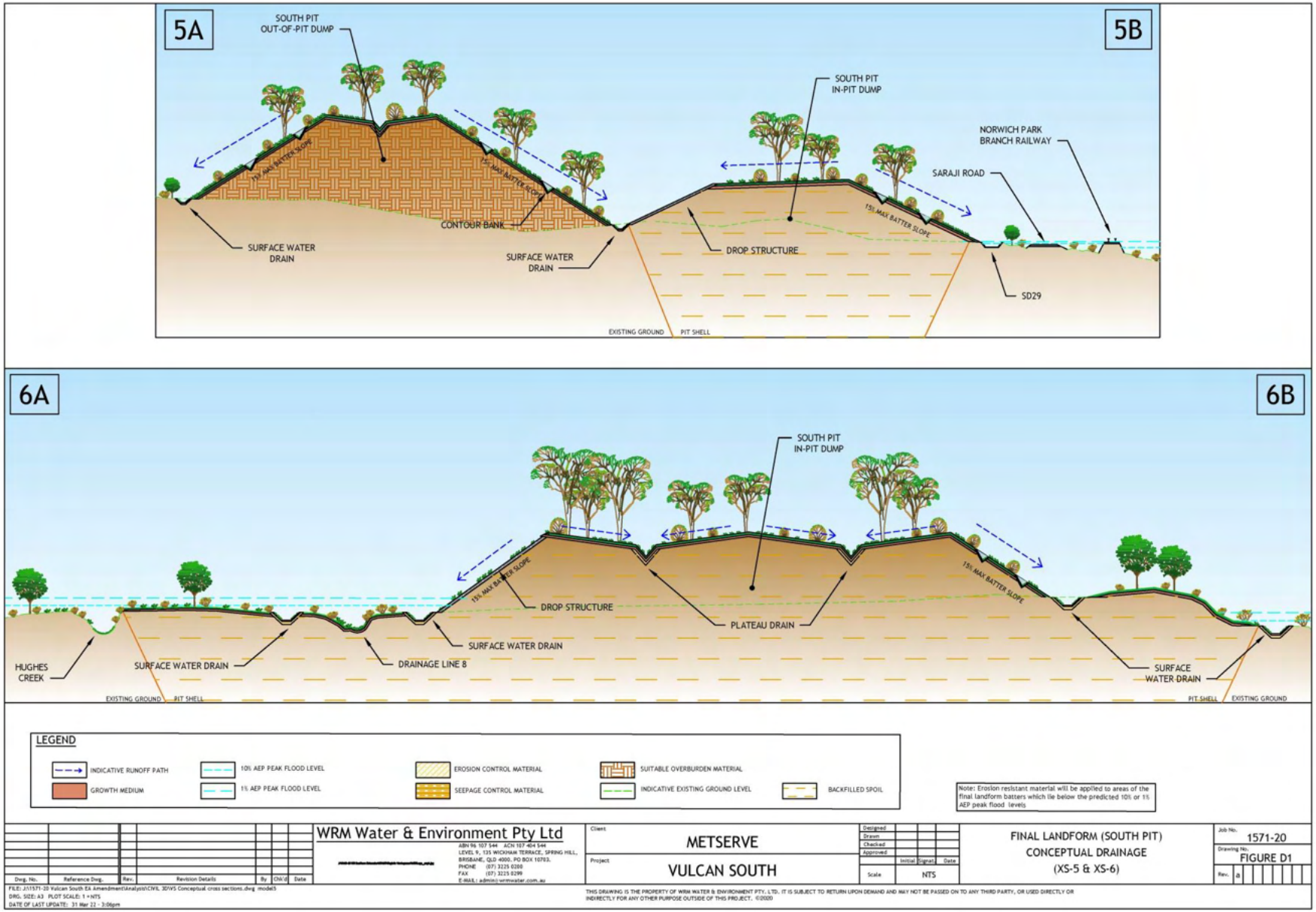


Figure 6-13 Vulcan South Final Landform Conceptual Design (XS-5, XS-6)

Water Management

The catchment areas of each of the mine water storages, as well as the assumed land use within each catchment are also shown in **Section 1.2.5**. The key water management features in the final landform include:

- no final voids are proposed as part of the final landform. The open cut pits will be backfilled with waste rock material;
- final landform batter slopes will be a maximum of 1(V):6(H) (approximately 15%);
- contour banks will be constructed on batters to limit topsoil erosion until vegetation has been suitably established;
- drainage structures will be constructed to direct runoff from disturbed areas to sediment dams;
- the plateaus include proposed drains and drop structures to drain the top of the landform to natural ground level;
- mine water dams will be decommissioned and rehabilitated to be in accordance with PMLU's;
- Drainage line 6 and Drainage line 8 will be reinstated through the Vulcan North and Vulcan South final landforms respectively; and
- the Hughes Creek floodplain will be reinstated through the Vulcan Main and Vulcan South landforms.

When a sediment dam's catchment is completely rehabilitated, and water quality monitoring has established that the runoff is consistent with natural background conditions, the sediment dam will be decommissioned.

When Drainage Line 6 is rehabilitated, DD2 will be decommissioned. DD2 will remain until this time to allow in-stream vegetation to establish along Drainage Line 6 before receiving upstream catchment flows. Further details of proposed water storages, including indicative storage sizes and pumping rules are provided in **Appendix A.**

Impacts on downstream water quality

Preliminary baseline monitoring indicates that water in the surrounding environment is of poor quality. The water balance modelling indicates that no mine-affected spills are predicted from mine operations. Modelling (**Appendix A**) predicts that the EC for spills from the sediment dams will be below the water quality objective (720 µS/cm) for baseflows of the Project area. In consideration of the heavily disturbed nature of the surrounding catchment, it is unlikely that the Project will have a measurable impact on receiving water quality or environmental values.

As described in **Section 6.2.9**, the landform evolution model determined that there would be negligible sedimentation effects on downstream waterways (**Appendix F**).

Impacts on downstream water quality will be monitored throughout the duration of operations and rehabilitation, and specific milestone criteria have been developed to ensure no downstream impacts occur (Section 9). In summary, the conceptual final landform is not considered likely to have a long-term significant impact on the receiving waters (**Appendix A**).

Flood Modelling

WRM (2023) has modelled the extent of flood plains within the Project and surrounding areas based on the final landforms described in **Section 6.2.1** (**Appendix A**). Peak water levels and peak velocities were compared to pre-mining conditions for the 10%, 1% and 0.1% AEP events.

Models show only minor changes to flood plain configuration and function under the final landform. Most impacts do not extend beyond the Project area. The models highlighted that erosion and scour protection will be required along the reinstated drainage lines and existing channels to mitigate the risk of rapid geomorphic change. These impacts are generally confined within the Vulcan South MLA. Existing conditions natural topography will be reinstated within the Hughes Creek floodplain, as well as Drainage line 6 and Drainage line 8 post-closure to replicate the existing drainage line channels to minimise the impacts associated with the post-closure conditions landform.

Overall, the impact of the Project on the hydraulic characteristics of Boomerang Creek, Hughes Creek and their tributaries do not affect the existing conditions significantly.

It is expected that the channel and floodplain will undergo little, if any, adjustment to the altered hydraulic conditions upstream or downstream of Vulcan South as a result of the Project.

The full details of flood modelling are found in **Appendix A**, along with full mapping of flood extents under existing, operational and post-closure conditions presented in **Appendix A** of that appendix.

6.2.7 Hydrogeology

Hydrogeologist.com.au (2022) has developed a numerical hydrogeological model of all relevant aquifers within the MLA area and broader region to predict the effects of the Project, on local groundwater levels. This was based on a range of data sources, including an on-site groundwater monitoring network, groundwater assessments from nearby mines, and the Queensland Groundwater Database (DNRME, 2020).

An adaptive management strategy is proposed to assist with the management and mitigation of any potential drawdown and water quality impacts on the site. The overall framework for the adaptive management strategy includes ongoing monitoring programs of groundwater level and water quality, and the development of site-specific groundwater trigger levels and contaminant limits.

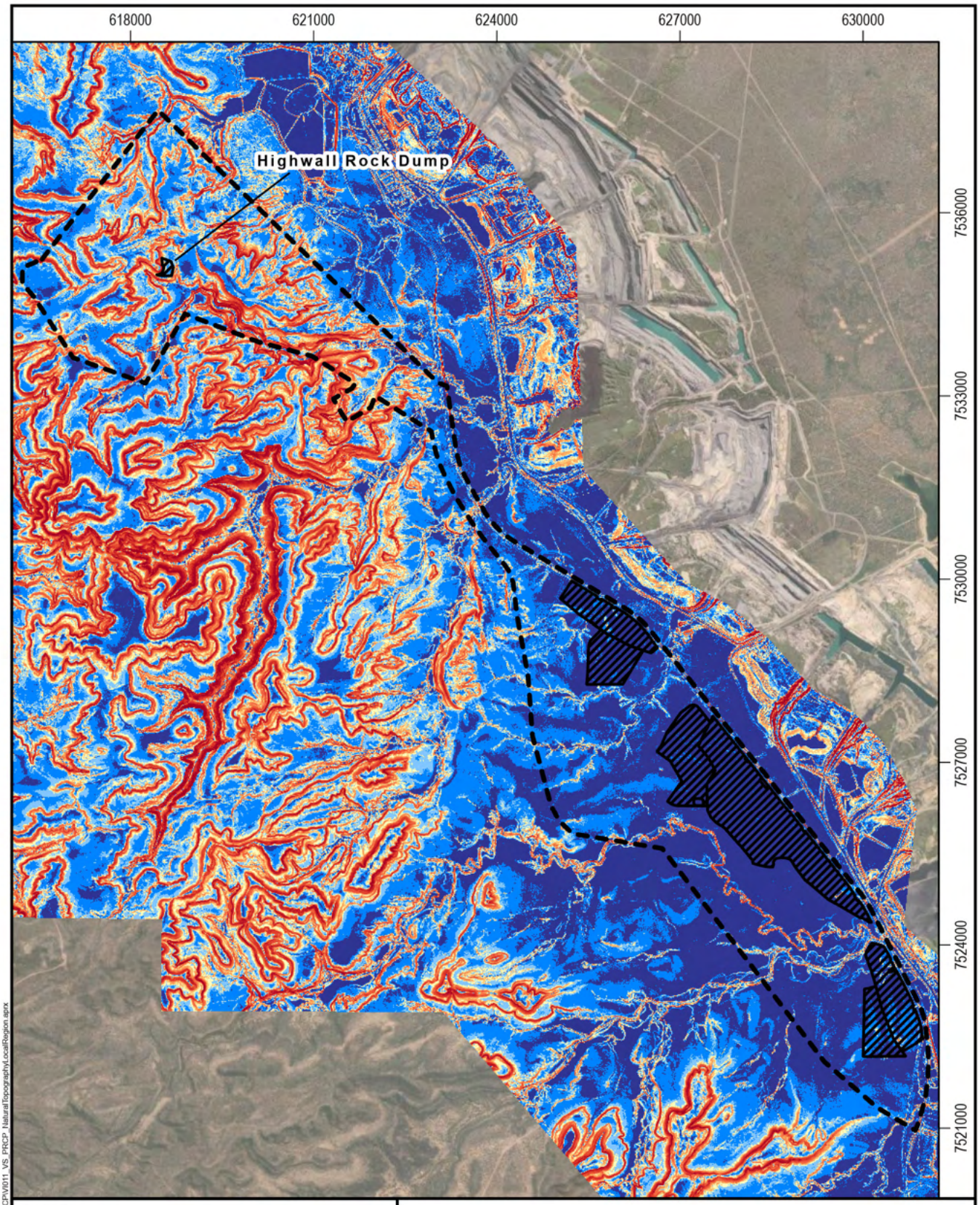
6.2.8 Predicted Stability

An extensive review of literature was undertaken to assess the local landscape, extent of protective cover of natural slopes, and slope stability in the region. Overall, that proposed final landform is expected to be stable under a post-mining land use of low-intensity cattle grazing. The following are the main lines of evidence for this:

- the final landform is similar to the topography of surrounding areas; the maximum slope proposed in the final landform is 15%, and 45% of the local landscape comprises grazed slopes that are naturally steeper than this;
- a 30% cover of rock mulch is applied to 10-15% gradients will be more than adequate for maintaining stability until vegetation establishes;
- studies conducted at other mines across the Bowen Basin have found that 15% gradients with only a moderate groundcover of 30-40% have very low erosion rates;
- other Bowen Basin mine sites regularly achieve vegetative cover of 30 to 100% on rehabilitated waste rock, which is more than adequate for maintaining the stability of 15% gradients; and
- even after considering the removal of vegetation expected from cattle grazing, a sufficient cover is expected to be maintained on rehabilitated sites in the long term.

Further discussion is provided in the subsection below.

The topography of the region is shown in **Figure 6-14.** The final landform has slopes comparable to the existing natural topography, which is stable under low-intensity grazing. A large percentage of the natural landscape surrounding the Mine is steeper than the maximum slope for the final landform.



Legend

- MLA Boundary
- Waste Rock Dump

Slope

- ≤5%
- 5-10%
- 10-15%
- 15-20%
- 20-25%
- 25-30%
- 30-35%
- 35-40%
- 40-45%
- 45-50%
- 50-55%
- 55-60%
- 60-65%
- 65-70%
- 70-75%
- 75-80%
- 80-85%
- 85-90%
- 90-95%
- ≥95%

Source: Vitrinite 2019-2022, METServe 2022, Earthstar Geographics.

Vulcan South

Natural Topography of the Local Region

0 1.5 3

Kilometers

Scale: 1:90,000 (A4)

13/03/2023

Datum: GDA2020
Projection: MGA55

FIGURE 6-14

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_NaturalTopographyLocalRegion.aprx

Extent of Protective Cover on Natural Slopes

Many naturally steep slopes in the local region maintain low erodibility via a high cover of rock, vegetation and leaf litter. Ecology surveys undertaken across the area surrounding and including the Project measured groundcover and slope. All sites were maintaining stability under low-intensity grazing. This data identified that when slopes were less than 20% there was no relationship between slope and percentage groundcover. These shallow slopes ranged widely in groundcover, from 40% to 95% (average = 70%). This implies that erosion is not an important force on these shallow slopes. Once slopes have a gradient exceeding 20%, increasing groundcover is required to maintain stability, and all natural sites with a slope greater than 40% had a groundcover exceeding 95%.

This data supports the notion that a final landform with slopes of 15% of less will not be at risk of erosion, provided a moderate cover of rock, vegetation and leaf litter can be established and maintained. Approximately 30% cover of rock mulch is to be applied to gradients of 10-15%. Rock is effective protection against erosion of waste slopes on newly rehabilitated mine sites (Williams 2001; Erskine & Fletcher 2013).

Rock will constitute approximately half of the protective cover required for maintaining long-term stability (based on the natural variation in cover observed in the region), while the remainder will be supplied by developing vegetation.

Previous Studies – slope stability

Other studies in central Queensland and elsewhere have investigated the stability of varying slopes on mine waste rock stockpiles and dumps. These are broadly consistent with the inferences about slope stability gained from investigating natural variation in slope and groundcover on the site.

Studies in Queensland demonstrated that any gradient exceeding 3.5%, if not protected by some sort of cover, will erode under average rainfall conditions, and extreme rainfall can erode bare slopes greater than 0.35% (Williams 2001). However, rock or vegetation cover drastically reduces erosion rates (**Figure 6-15**).

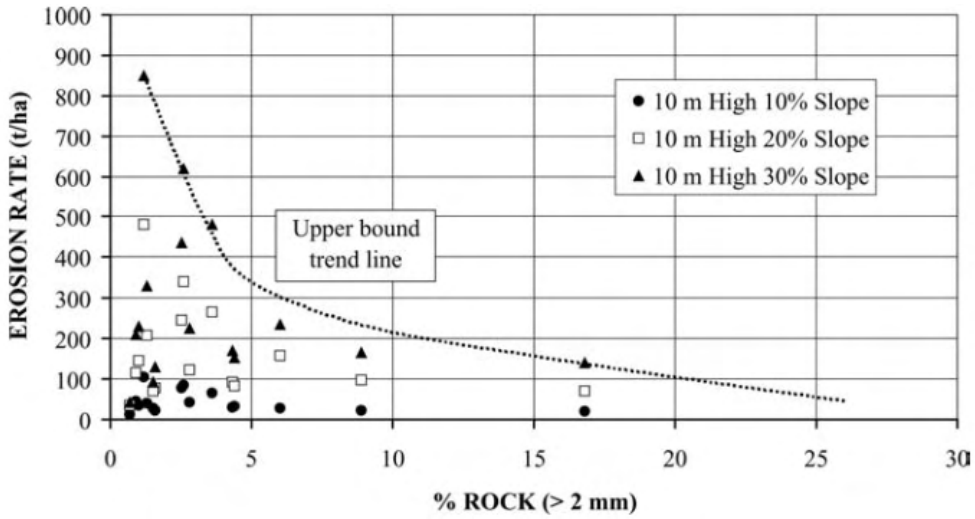


Figure 6-15 Erosion rate versus percentage rock for Bowen Basin soil materials (Williams, 2001)

The amount of cover required to protect slopes of various gradients from erosion has been investigated in numerous trials across Central Queensland. Carrol and Tucker (2000) found negligible differences in soil erosion for 10%, 20% and 30% slope gradients once vegetation established (**Figure 6-16**). Both Carroll *et al.* (2010) and Waters (2004) found that maintaining ground cover at 40-60% was sufficient in reducing erosion to negligible levels (<0.5 t/ha), regardless of slope. Likewise, a trial undertaken at Tarong, which simulated a heavy rainfall event on a 15% slope, found that 30-40% ground cover was sufficient to protect against erosion (Loch 2000: **Figure 6-17**).

In light of published data, the approximate 30% rock cover proposed for slope gradients of 10-15% will provide sufficient protection for these slopes during periods of low vegetation cover (e.g., initial phase of rehabilitation, or following fire or drought). An additional vegetation cover of 50% (total groundcover of 80%) is expected to provide a highly stable landform in the long-term.

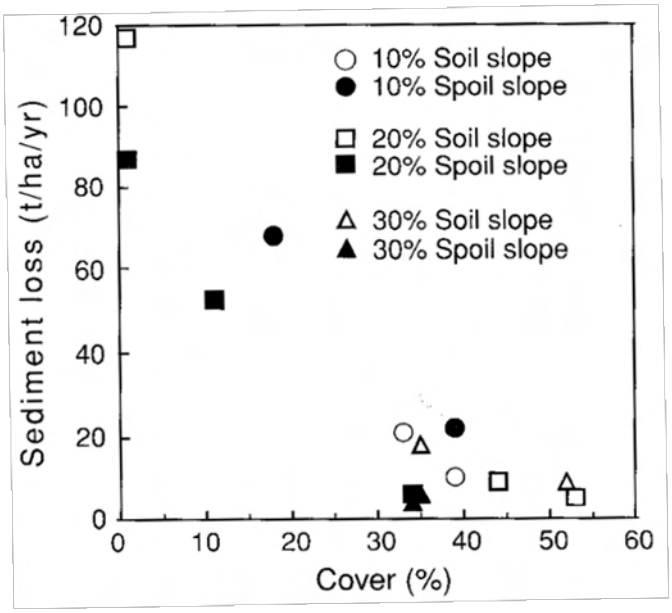


Figure 6-16 *Annual sediment loss versus pasture cover on soil and spoil stockpiles at Oaky Creek (Figure from Carrol and Tucker 2000)*

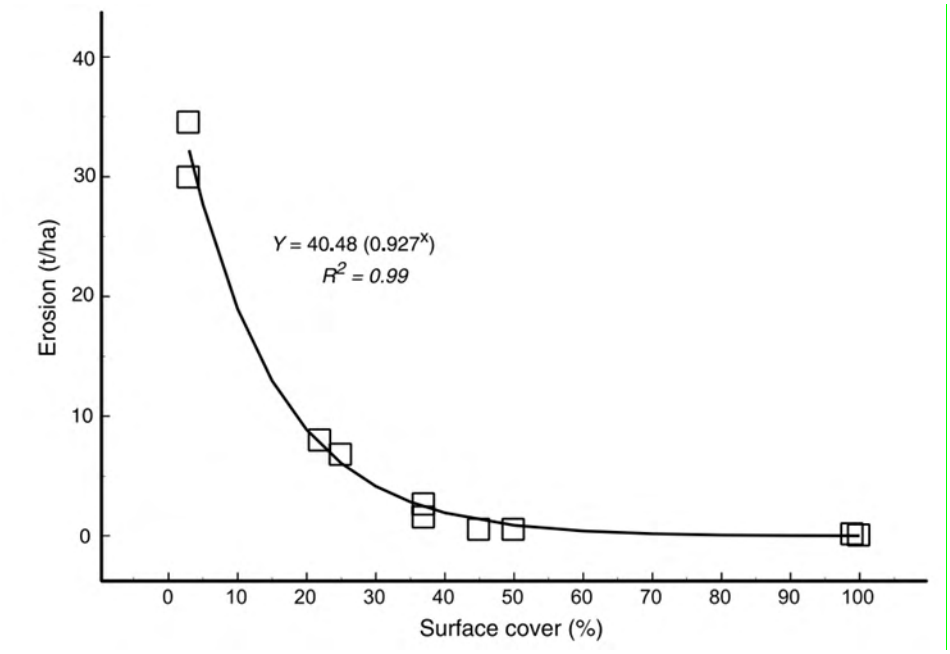


Figure 6-17 *Effects of surface cover on erosion from 12-m-long plots with 15% slope under simulated rain at Tarong (figure from Loch 2000).*

Previous Studies - Stability of Grazed Slopes

The above review of available data presents a coherent case for the proposed Project final landforms having low erodibility provided they have a moderate vegetation cover of 10-20%. However, in order for the landforms to have long-term stability, they must also support the prescribed post-mine land use of low-intensity grazing. Livestock affect landform stability by removing a portion of the vegetation cover and damaging soil surface structure via trampling (Blackburn 1983). For this reason, a review of published data concerning stability of slopes under grazing was undertaken.

Comparisons between adjacent grazed and ungrazed pastures at Charters Towers found that grazing regimes prevalent at the time reduced protective cover (vegetation and leaf litter) by 0‑88% (mean of 41%), depending on seasonal conditions (Scanlan et al. 1996). Ludwig and Tongway (2002) found this reduction in cover to be less severe; grazing led to an 11% reduction in perennial grass cover and a 29% reduction in canopy cover of trees (correlated with leaf litter cover). Taken together, this data predicts that grazing in central Queensland removes, on average, approximately 1/3 of the vegetative groundcover. When this is taken into account, a target vegetative cover (grass, herbs and leaf litter) of 15-30%, in addition to the 30% rock cover proposed to be added to slopes, will be required in an ungrazed rehabilitated landscape to achieve a target cover of 40-50% once grazing is introduced. Given that other Bowen Basin mine sites regularly achieve vegetative cover of 30 to 100% (Carrol and Tucker 2000; Erskine and Fletcher 2013), a pre-grazing target of 15-30% vegetative cover is highly likely to be achieved at the Project.

Cattle currently graze natural slopes with gradients well in excess of 15% without compromising the stability of these slopes. However, the steepest slopes are somewhat protected from grazing because cattle prefer not to graze such areas (Mueggler 1965; Ganskopp & Vavra 1987). Nevertheless, gradients of 15% are well within the range of slopes utilised by cattle for grazing (Ganskopp & Vavra 1987), and the landform proposed for the Project is consistent with low-intensity grazing.

Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower then 10%;

Geotechnical Assessment

A geotechnical assessment of Vulcan South's final landforms was undertaken by Blackrock Mining Solutions (**Appendix G**). The following considerations were used for the assessment:

- circular failure analyses using the auto-refine search algorithm and the general limit equilibrium method for spoil failures;
- a basal saturated spoil layer of approximately 5 m thickness was assumed for final landform slope stability assessment; and
- co-disposal of dry tailings in both the in-pit and ex-pit dumps.

Limit equilibrium analyses were assessed in terms of a circular failure mechanism acting through the unsaturated and saturated Category 2 spoil material, for in-pit and ex-pit dump final landforms, respectively (see Geotechnical assessment – **Appendix G**) .

Analyses returned critical Factor of Safety (FoS) values of 2.56 and 4.03 for the in-pit and ex-pit final landforms, respectively. The Vulcan North, Main and South in-pit WRD's returned a FoS of 3.01, 2.56 and 3.14, respectively. The Vulcan North, Main and South ex-pit WRD's returned a FoS of 3.48, 3.99 and 4.03, respectively. The FoS is a measure of driving forces versus resisting forces in a system. FoS values > 1 are indicative that a system is likely to be stable, while an FoS value of 1.5 is considered to be the generally accepted value for long-term slope design. The proposed final landform design exceeds the minimum FoS of 1.5 for all landform features, and is therefore acceptable from a geotechnical perspective.

6.2.9 Landform Evolution Modelling

Landform evolution modelling (LEM) was undertaken for the six proposed WRDs. These included the Vulcan North in-pit and ex-pit WRDs, Vulcan Main in-pit and ex-pit WRDs, and the Vulcan South in-pit and ex-pit WRDs. The LEM assessed the ability for the proposed WRD cover designs and embankment slopes to demonstrate that landform rehabilitation criteria are achievable and should result in long-term stability.

Erosion behaviour was simulated using SIBERIA software for the six proposed WRD landforms over a 10-year and 100-year timeframe. Slope angle, length of slope, dispersive characteristics of soil units, sediment transport information, and percentage of ground cover are important factors affecting erosion and are inputs to the model. The LEM analysed five proposed landform cover management scenarios to determine which is the most suitable for the longevity of a stable landform.

Erosion modelling predicted rilling, gully erosion and sedimentation for each of the potential cover design scenarios, which were compared to rehabilitation objectives.

An erosion risk rating was determined for each of the cover designs based on these rehabilitation objectives. The LEM predicted that once the proposed WRD landforms have fully established a cover of rock mulch with grass cover, rehabilitation objectives as outlined in the PRC Plan would be achieved. Erosion objectives achieved with this cover design in place include:

- Land is stable, with only minor active rills no deeper than 0.25 m;
- Erosion only affecting uppermost topsoil layer;
- Negligible sedimentation effects on downstream waterways; and
- Vegetative cover is effective, but may have reduced ability to recover following disturbance from mining in some areas.

Recommendations of the assessment include monitoring the proposed WRD rehabilitation areas until all milestone criteria have been met and the target vegetative cover is established.

More detailed information about the LEM is contained in the LEM Assessment Report (**Appendix F**).

6.3 Revegetation Plan

6.3.1 Revegetation Objectives

The following are the revegetation objectives for the site, consistent with the proposed PMLUs:

- to ensure rapid establishment of vegetation on exposed soil, to limit erosion over the early stages of rehabilitation;
- to establish a pasture with native and exotic grass species that is sufficiently dense in the long term to protect the soil surface from erosion and support low-intensity grazing;
- to establish a moderate density of locally native trees and shrubs that provide shade for livestock and sufficient cover for the vulnerable Squatter Pigeon;
- to establish a moderate density of Koala food trees;
- to establish a similar amount of food for the Glossy Black-Cockatoo as present pre-mining;
- to establish a similar variety of Greater Glider food trees as present pre-mining; and
- to limit invasion by declared weed species to levels that are similar to those on site prior to mining or representative of adjacent areas.

6.3.2 Key Flora Species

The flora species to be planted in disturbed areas vary depending on the topsoil type used at each site. The flora species selected represent the dominant species in regional ecosystems that grow naturally on each soil management unit (**Table 6-3**). It is anticipated that many of these species may not be available from commercial seed providers. Therefore, it is expected that much of the seed used for rehabilitation efforts on site will require local collection by contractors.

Table 6-3 Key flora species on each soil management unit

Soil Type	Target RE	Dominant Trees	Dominant Midstorey	Dominant Grasses
Crocodile	11.10.1, 11.10.3, 11.10.1x1.	*Acacia shirleyi, Corymbia aureola, Corymbia citriodora, Corymbia trachyphloia, Eucalyptus crebra.*	*Acacia bancroftiorum, Acacia burdekensis, Acacia flavescens, Alphitonia excelsa, Dodonaea lanceolata, Erythroxylum australe.*	*Alloteropsis cimicina, Cleistochloa subjuncea, Cymbopogon refractus, Digitaria diminuta, Eriachne obtusa, Melinis repens*, Paspalidium caespitosum, Themeda triandra, Thyridolepis xerophila, Urochloa piligera.*
Fish	11.10.3	*Acacia rhodoxylon*	*Carissa ovata, Erythroxylum australe.*	*Alloteropsis cimicina, Cenchrus ciliaris*, Cleistochloa subjuncea, Eriachne obtusa, Melinis repens*, Paspalidium caespitosum.*
Kei	11.5.3	*Eucalyptus populnea, Corymbia dallachiana, Alphitonia excelsa, Ventilago viminalis,*	*Acacia burdekensis, Acacia excelsa, Carissa ovata, Cassia brewsteri, Eremophila mitchellii, Erythroxylum australe, Melaleuca nervosa, Vachellia bidwillii.*	*Alloteropsis cimicina, Aristida calycina* var. *calycina, Aristida gracilipes, Bothriochloa pertusa*, Cenchrus ciliaris*, Chrysopogon fallax, Eragrostis speciosa, Eriochloa crebra, Perotis rara, Urochloa piligera.*
Komati	11.9.2	*Eucalyptus orgadophila, Corymbia erythrophloia, Ventilago viminalis*	*Acacia excelsa, Atalaya hemiglauca, Bursaria incana, Carissa ovata, Cassia brewsteri, Denhamia cunninghamii, Erythroxylum australe, Vachellia bidwillii.*	*Bothriochloa pertusa*, Enneapogon* sp., *Cenchrus ciliaris*.*
Limpopo	11.5.9, 11.5.3	*Corymbia clarksoniana, Eucalyptus crebra, Eucalyptus melanophloia, Eucalyptus populnea,*	*Acacia burdekensis, Alphitonia excelsa, Cassia brewsteri, Erythroxylum australe, Grevillea parallela, Grevillea striata, Melaleuca nervosa, Petalostigma pubescens.*	*Alloteropsis cimicina, Aristida calycina* var. *calycina, Aristida gracilipes, Bothriochloa bladhii, Bothriochloa pertusa*, Cenchrus ciliaris*, Chrysopogon fallax, Eragrostis sororia, Eragrostis speciosa, Eriachne obtusa, Eriochloa crebra, Melinis repens*, Perotis rara, Setaria surgens, Urochloa piligera.*
Orange	11.4.8, 11.4.9	*Acacia harpophylla, Bauhinia hookeri, Casuarina cristata, Eucalyptus cambageana, Terminalia oblongata, Ventilago viminalis.*	*Carissa ovata, Eremophila mitchellii, Terminalia oblongata.*	*Ancistrachne uncinata, Cenchrus ciliaris*, Chloris divaricata, Chloris ventricosa, Eragrostis lacunaria, Paspalidium constrictum, Urochloa mosambicensis*.*

Soil Type	Target RE	Dominant Trees	Dominant Midstorey	Dominant Grasses
Sabie	11.10.3, 11.10.1x1, 11.10.7	*Acacia rhodoxylon, Acacia shirleyi Alphitonia excelsa, Corymbia aureola Corymbia citriodora, Corymbia clarksoniana, Eucalyptus crebra, Eucalyptus exserta, Eucalyptus melanophloia.*	*Acacia bancroftiorum Acacia burdekensis, Acacia curvinervia, Acacia flavescens, Alphitonia excelsa, Erythroxylum australe, Leptospermum lamellatum, Petalostigma pubescens.*	*Alloteropsis cimicina, Cleistochloa subjuncea, Cymbopogon refractus, Digitaria diminuta, Eriachne obtusa, Melinis repens*, Paspalidium caespitosum, Themeda triandra, Thyridolepis xerophila, Urochloa piligera.*
Zambezi	11.3.2, 11.3.7, 11.3.25	*Corymbia clarksoniana, Corymbia tessellaris, Eucalyptus camaldulensis, Eucalyptus crebra, Eucalyptus populnea, Melaleuca leucadendra.*	*Alphitonia excelsa, Bauhinia hookeri, Carissa ovata, Cassia brewsteri, Ficus opposita.*	*Bothriochloa ewartiana, Bothriochloa pertusa*, Cenchrus ciliaris*, Megathyrsus maximus*, Urochloa mosambicensis*.*

*Exotic pasture plants common on each soil prior to mining

6.3.3 Species of Conservation Significance

Where this is consistent with a proposed PMLU, habitat for threatened fauna inhabiting the Project area is to be incorporated into the landscape. The following subsections detail how this will be achieved for each species of conservation significance potentially impacted by the Project, as identified in **Section 1.2.10**.

Koala

Habitat for Koalas can be incorporated into PMLUs of "low-intensity cattle grazing" and "native ecosystems". This will be achieved by ensuring that trees established to provide shade for livestock are also food trees for Koalas. The tree species to be planted (via inclusion in the seed mix) vary by soil type, as shown in **Table 6-4**.

Table 6-4 List of Koala food trees suitable for planting on each soil management unit

Soil Management Unit	Suitable Food Trees
Crocodile	*Eucalyptus crebra*
Fish	None
Kei	*Eucalyptus populnea*
Komati	*Eucalyptus orgadophila*
Limpopo	*Eucalyptus populnea, Eucalyptus crebra*
Orange	None
Sabie	*Eucalyptus crebra*
Zambezi	*Eucalyptus camaldulensis* (on creek banks), *Eucalyptus populnea, Eucalyptus crebra,*

Greater Glider

Habitat for Greater Gliders can be incorporated into some PMLUs of "low-intensity cattle grazing" and "native ecosystems", primarily along the banks of drainage lines. The following food trees are to be included in seed mixes sown within 50 m of a watercourse or drainage line on the Zambezi soil unit: *Eucalyptus camaldulensis, Eucalyptus crebra, Eucalyptus populnea, Corymbia clarksoniana, Corymbia dallachiana* and *Corymbia tessellaris.*

Squatter Pigeon

Habitat for Squatter Pigeons can be incorporated into PMLUs of "low-intensity cattle grazing" and "native ecosystems" on all soil types contained within the Project, with the exception of the Crocodile and Sabie soil management units (rocky, sandstone-derived soils provide unfavourable foraging substrates).

Squatter Pigeons have two chief habitat needs that require restoration in rehabilitation sites: (1) a diversity of native and introduced pasture grasses and herbs (on which to feed) in the understorey; and (2) a minimum tree cover that generates a Normalised Differential Vegetation Index of at least 0.125 (measured across a 1-ha cell in the late dry season).

As these habitat features are generally co-located in productive pastures (related to understorey productivity and diversity) and sites with Koala habitat (a moderate tree cover), a PMLU of "low-intensity grazing", with a low-moderate tree cover for livestock shade and Koala habitat is likely to provide habitat for Squatter Pigeons with no additional management inputs.

Glossy Black-Cockatoo

Glossy Black-Cockatoo feed only on *Casuarina cristata* locally, and this canopy species is to be included in seed mixes applied to level ground with the "Orange" soil management unit. Areas where water pools are likely to be particularly favourable for this tree. Conversely, slopes that retain little water are unlikely to be suitable.

6.3.4 Topsoil Management

Topsoil is the most valuable soil horizon for post-mining rehabilitation. Topsoil contains a seed bank, micro-organisms and nutrients necessary for plant growth. In contrast, many of the subsoils on site are sodic and prone to dispersion (AARC, 2022). The soil characteristics of each soil management unit present on site (**Section 1.2.7**) were used to determine the maximum depth to which suitable topsoil material should be stripped for stockpiling and/or rehabilitation, in order to conserve an optimal growth medium for plants (**Table 6-5**).

Table 6-5 Recommended maximum topsoil stripping depths for each soil management unit

Soil Management Unit	Stripping Depth (m)*	Qualities
Crocodile	0.1	Topsoil is strongly acidic, very rocky and not suitable for establishing improved pastures. It is most suited to a PMLU of native ecosystems similar than those naturally occurring on site.
Fish	0.1	Topsoil is suitable for all rehabilitation purposes to 0.1 m depth, though acidic (pH 5.5) is within the range for plant growth. Becomes sodic (potentially dispersive) below 0.1 m.
Kei	0.6	Topsoil is suitable for all rehabilitation purposes to depth of 0.6 m having low salinity, suitable pH and low exchangeable sodium percentage. Below 0.6 m this SMU is increasingly alkaline and may have a reduced availability of plant nutrients.
Komati	0.1	Topsoil is suitable for all rehabilitation purposes to 0.1 m depth. Below 0.1 m soil becomes increasingly alkaline and dispersive.
Limpopo	0.3	Topsoil is favourable for plant growth but has a low nutrient-holding capacity and should be improved with fertiliser when planting. These very sandy soils are prone to slumping and should not be used on slopes exceeding 3%. Subsoils are susceptible to dispersion.
Orange	0.1	Topsoil is suitable for all rehabilitation purposes to 0.1 m depth though moderate alkalinity may have an inhibiting effect on plan nutrient availability. Below 0.1 m there is a risk of dispersion and will be limited in its potential to be used as a topsoil /growth medium.
Sabie	0.1	Topsoil is suitable only for rehabilitation to a native ecosystem. Surface soil is acidic (pH 4.6) limiting plant nutrient availability and increasing risk of aluminium toxicity. Below a depth of 0.1 m sodicity increases and therefore so does dispersion risk.
Zambezi	0.3	Topsoil is favourable for plant growth but has a low nutrient-holding capacity and should be improved with fertiliser when planting. Below 0.3 m, soils are sodic and dispersive. The very sandy topsoil should not be used on slopes exceeding 3%.

*Recommendations from AARC (2022)

Topsoils and subsoils are to be stored separately. Likewise, soils from different soil management units are to be managed separately. Where possible, soils should be directly placed in prepared rehabilitation areas rather than stockpiled. This conserves a viable seedbank and promotes revegetation.

Topsoil Stockpiling

Where stockpiling of topsoil is required, the following actions are to be taken to reduce the risk of soil degradation and improve the chances of rehabilitation success:

- topsoil stockpiles should be less than 2 m high and be contoured and positioned in a manner that encourages water drainage and discourages erosion. Grass and herbaceous plants germinating from the soil seed bank are to be maintained as a protective cover for stockpiles;
- if stockpiles fail to develop a natural grass cover, they are to be seeded with a fast-growing, non-invasive, commercially available sterile grass species (recommended species are listed in the *Soil Conservation Guidelines for Queensland* (DSITI 2015));
- topsoil should be stockpiled for the minimum time practicable. Studies in the Hunter Valley have shown that the majority of deterioration occurs within the first year (Keipert *et al.* 2005);
- stockpiles are to be monitored annually for weeds and control measures implemented as appropriate;
- where soil must be stockpiled for extended periods (>2 years), soil will be tested before use for rehabilitation purposes; and
- topsoil stockpiles are to be located in areas fenced from livestock
- Storage of SMU's separately to prevent contamination.

Organic matter application

Sandy soils usually have poor soil structure, low moisture retention and low available nutrient concentrations.

The addition of organic matter to such soils helps to bind soil aggregates together and resist physical breakdown, improving soil structure. This in turn increases soil moisture retention and re-incorporates nutrients back into the soil. Where possible, topsoil should be stripped with its existing ground cover vegetation and, if subject to stockpiling, relocated with its cover crop vegetation.

Depending on availability, additional organic matter (such as mulches, manures, or compost), may be incorporated into the topsoil. Organic materials incorporated into the topsoil will increase organic carbon levels, providing more exchange sites for necessary cations, increase water holding capacity, and ensure less organic matter is oxidised into carbon dioxide and nitrous oxide or reduced into methane (**Appendix C**).

Application rates will vary depending on mulch type. Straw mulch should be applied at a rate of 5 t/ha. Note that fresh mulch should not be used in acidic soils. Manure should be incorporated at rates of 5-30 t/ha (depending on the type of manure). If available, compost can be applied at 70-150 t/ha (**Appendix C**).

Fertiliser Application

Fertilisers may be utilised to increase nutrient concentrations in soil. Presence of acidic soils within the Project area means that care must be taken, as some fertilisers (such as ammonium-based fertilisers) can have an acidifying effect on the soil. Were this to occur, lime applications would be required to mitigate the fertiliser's acidifying effects. Topsoil stockpiles from each of the soil units will be tested prior to use in rehabilitation to ascertain fertiliser requirements.

A calcium nitrate-based fertiliser such as calcium ammonium nitrate (15 to 27% N) is suitable for this application as it has near-neutral effect on soil pH and can be used to increase both nitrogen and calcium levels in the soil. An application rate of 25-50 kg N/ha should be sufficient for successful vegetation establishment (CRDC, 2020). This could be complemented with an application of sulphate of potash (41 % K) to increase potassium levels in the soil.

This fertiliser would also increase sulphur and can be drilled with seeds (unlike other potassium fertilisers such as muriate of potash which can damage seed germination). Typical application rates of potassium for pastures in light soils are of around 20 kg K/ha (**Appendix C**).

Alternatively, urea (46.7% N) may be applied as a nitrogen fertiliser (usually the most economical nitrogen fertiliser), but this would need to be applied in combination with lime (calcium carbonate), to overcome the acidifying effects of urea. A rate of 150 kg/ha of urea is recommended for soils in low rainfall areas where soil nitrate content is below 3 mg/kg. Limestone application rates should be around 1 t/ha of lime.

It is expected that 1 t/ha of lime (incorporated in the first 10 cm of soil) will increase the pH of sandy soils by 0.57 units (Department of Primary Industries n.d.). Follow up pH testing will be undertaken to evaluate the need to add more lime – lime would be added initially at small doses and then at gradually increasing application rates as necessary.

Phosphorus application rates would be carefully determined, as many Australian native species are adapted to low phosphorus concentrations in the soil. Application rates of 10-20 kg P/ha have been suggested for grazing pastures (Victoria Government 2013) and mine restoration (Daws *et al.* 2013). To achieve this, single superphosphate (8.8% P) could be applied, which would also supply sulphate. (Note this fertiliser should not be blended with urea).

After application, soil ameliorants will be incorporated into the soil to approximately 0.3 m (for example by using a scarifier or ripper tynes) so they are not lost by wind or washed away by rainfall. Ideally, after vegetation establishment (after 6 to 12 months since sowing) soils will be re-tested to determine if any follow-up application of ameliorants is required.

Besides using fertilisers, incorporating native leguminous forbs such as *Rhynchosia minima* (Rhynchosia) and tomentella (Hairy Glycine) to the seed mix is a natural method of increasing soil nitrogen levels due to the nitrogen fixing capabilities of legume species. This could establish natural nitrogen cycling within the topsoil resulting in long-term improvements in soil fertility and self-sustaining vegetation.

6.3.5 Subsoil Management

Many of the subsoils within the Project are dispersive and must be managed carefully to reduce the risk of erosion and sedimentation of downstream waterways. Most of these subsoils do not provide a favourable substrate for plant establishment. Instead, the following actions, where practicable, are to be taken to manage the storage of subsoils:

- subsoil to be directly placed into its final position rather than stockpiled as a priority;
- subsoil stockpiles to be contained, to ensure that any eroded material is retained within the pits and not released into waterways;
- subsoil stockpiles should not to be placed on slopes greater than 3%, and the stockpile surface should be levelled to reduce the speed of any run-off; and
- Sediment control infrastructure is to be constructed around all stockpile areas.

Where dispersive subsoil material is to be utilised in rehabilitation works, it will tested, and if required, treated with gypsum (calcium sulphate) prior to sowing/planting.

Dispersive soils generally have low porosity, low air movement and therefore low oxygen availability for plants. They also have slow water infiltration which can lead to waterlogging. Gypsum application rates for moderate to severe dispersive soils usually range from 2.5 to 5 t/ha depending on site-specific characteristics (DPIRD, 2020).

Given the high exchangeable sodium percentage in sodic subsoils, an application of 5 t/ha of gypsum is recommended (AARC, 2022). Gypsum will cause soil particles to flocculate, therefore improving soil structure, increasing water and plant root penetration into the soil. Irrigation will also be important where required. These soils should be well irrigated so that sodium moves down the soil profile. In contrast, low amounts of water in the soil can result in sodium moving up the soil profile by evaporation.

The Crocodile and Kei SMUs represent an opportunity for use as a soil resource, given their non-sodic nature throughout the depth profile. If available as a soil resource, consideration will be given to incorporating ameliorants to address the pH limitations of these materials and improve their potential to support a rapid and successful rehabilitation outcome.

6.3.6 Revegetation Approach

Soil Spreading

A growing medium of 0.25 m of topsoil will be placed over the subsoil/waste-rock deposits described in **Section 6.1.3**. Organic material harvested from the mine footprint will be incorporated into the topsoil.

Following the spreading of topsoil, rehabilitated areas are to be ripped to a depth of 0.4 to 0.5 m. Ripping reduces compaction from heavy machinery, encourages the infiltration of water and reduces the risk of erosion. If engineered waterways are included in the landform, areas should be ripped on a grade (e.g. 0.5%). Otherwise, areas should be ripped on the contour.

Spread and ripped (at a grade of 0.5%) soil should have a rough surface with abundant troughs and banks, which help to resist erosion, improve infiltration and retain litter. In accordance with the results of trials elsewhere in the Bowen Basin (Williams 2001), a rock cover (sourced from waste rock) is to be placed upon topsoil on slopes greater than 10% (equivalent to 6°). This rock is to constitute approximately 30% of the soil cover, to convey optimal erosion protection during the initial stages of vegetation establishment (Williams 2001) (**Appendix C**).

Topsoil placement should occur in October-November, shortly before the commencement of the wet season. Soil operations are to be undertaken when the soil is dry or damp, but not saturated. Manual handling of wet soils is logistically difficult, damages the soil's structure and leads to compaction.

Contour banks on slopes will be constructed at a spacing of 80 m for slopes of 1V:6H (MCA 1998). Larger contour drains are generally more stable and longer lasting. Berms should be constructed of compacted material (IE Aust Erosion and Sediment Control Guidelines). Contour banks should convey water to engineered rock-lined spine drains on steep slopes. A competent basalt or alternative rock source is recommended. Geofabric in construction of rock-lined spine drains will be used where feasible (**Appendix C**).

Fertiliser and Soil Amelioration

Most of the topsoils within the Project area are nutrient-deficient, and the addition of an initial fertiliser application at the time of planting will facilitate plant establishment and growth. A controlled-release fertiliser with the following nutrient concentrations is to be applied at the time of seeding as required:

- Nitrogen: 15.0-27.0%;
- Phosphorus: 8.8%%; and
- Potassium: 41%

Application rates should follow the manufacturer's guidelines, but are expected to be 100-500 kg/ha, depending on nutrient concentrations. Further detail on specific application rates of fertilisers if required for amelioration of different anticipated conditions is also outlined above.

Seeding

Seeding operations shall not take place until the prepared area has been constructed in accordance with the specified requirements. Ideally, sowing should take place within one week of topsoil placement and ripping. Rainfall between cultivation and sowing results in the partial collapse of furrows and crusting of the soil surface. Sites may need to be re-ripped prior to sowing if rain occurs following the initial treatment. Seeding operations are not to be undertaken on days:

- when wind speeds exceed 15 km/h;
- where the surface is fully saturated;
- when temperatures exceed 37°C; and

- during heavy rain, or when heavy rain is imminent.

The seed mix to be applied varies by soil management unit (**Section 6.2.4**). However, all seed mixes are to include a combination of sterile grass varieties (e.g., Silk Sorghum *Sorghum* spp. and/or Japanese Millet *Echinochloa esculenta*)—which act as cover crops—native species and pasture species.

The seed mix is to be uniformly blended with a bulking agent such as dry sand or dry, fine sawdust at a rate of 1 part seed to 5 parts bulking agent by volume. This mix is then combined with fertiliser on the day of planting and distributed evenly across the planting area. Seed may be pre-mixed and stored with the bulking agent for several months; however, fertiliser should not be stored with seed for longer than necessary.

Hydromulching

Where deemed appropriate on the steepest banks or other areas that are more disposed to potential erosion, Hydromulching will be implemented. Hydromulching will be undertaken with a slurry of water, seed, fertiliser, mulch and a binder to contribute to ideal growing conditions and rapid vegetation through the stabilisation of the landform, incorporation of organic matter and nutrient addition.

Planting of Container Stock

Some species of trees and shrubs (especially those with fleshy fruits, such as *Erythroxylum australe* and *Carissa ovata*) recolonise poorly from directly sown seed, and are best reared in a nursery environment and planted as one-year-old tube stock. Monitoring of previous years' progressive rehabilitation on site (i.e., detecting the failure of certain species to germinate *in situ*) will inform which species should be prioritised for container stock in ongoing rehabilitation campaigns.

Container stock is to be hand-planted in clusters of 5-10 individuals, each seedling spaced approximately 2 m apart. The planting of container stock is to take place within five days of heavy rain (>40 mm over a 24 hr period), when soil moisture levels are high. The spacing between clusters will depend on the density of other species that successfully germinate, but planting densities of up to 100 trees per hectare may be required where seed germination is particularly poor.

All container stock is to be sun-hardened for at least one month prior to planting.

Planting holes are to be excavated to a minimum diameter equivalent to twice the diameter of the plant container and to a depth equivalent to the height of the plant container. The material at the bottom of the hole is to be broken up to a depth of 50 mm. The sides of the hole are to be roughened. The top of the plant's root ball is to be level with the surrounding ground. The topsoil is to be tamped down to create a slightly depressed basin surrounding the plant, without exposing the root system.

Fencing

Livestock-proof fencing is to be installed around all revegetated areas at or prior to the completion of seeding and planting. Rehabilitated areas are to be maintained free of livestock until these sites are sufficiently established for the commencement of grazing.

6.3.7 Seed Mix

Seed is to be sourced from a combination of local collections and commercial suppliers. Local seed collections will begin at least two years prior to the commencement of rehabilitation, to allow for the potential of unfavourable weather to cause the failure of seed production in any one year. Seed is to be stored for a maximum of five years prior to use, and regular collections/purchases will be required throughout the duration of the Project.

The preliminary seed mixes that are proposed for each soil management unit are shown in **Table 6-6**.

These have been developed based on the dominant species of trees, shrubs and grasses present within each soil management unit within the Project area prior to mining. Adjustments to these seed mixes will be made pending seed availability, the results of rehabilitation trials (**Section 6.3.8**) and the performance of the earliest rehabilitation efforts on site. It is expected that some of the species listed will display poor recruitment via direct seeding, and such species will be removed from the seed mixes and planted as container stock instead.

The value of Buffel Grass (*Cenchrus ciliaris*) for mine rehabilitation in Queensland is debated. This exotic pasture species is a rapid coloniser of disturbed ground and is effective for controlling erosion. Among earlier rehabilitation efforts in the Bowen Basin, Buffel Grass was the dominant pasture species planted (Grice *et al.* 2012). However, it is only moderately palatable to cattle and aggressively outcompetes other plant species, including more valuable pastures (Grice *et al.* 2012; Erskine and Fletcher 2013). Buffel Grass is considered the likely cause of a marked decline in species diversity over time at other mine rehabilitation areas within the Bowen Basin (Erskine and Fletcher 2013). This declining diversity jeopardises the stability and functionality of the rehabilitated landforms.

At the Project, Buffel Grass (*Cenchrus ciliaris*) is included within seed mixes on soil management units in which it was dominant pre-mining, but in much lower ratios than observed in reference sites. This approach is a compromise between replicating the pastures occurring on site prior to mining and establishing a diverse mix of native and exotic pasture species that have high pasture productivity and environmental value (i.e., can sustain the proposed PMLUs).

Table 6-6 Seed Mix Species List as per approved PRCP schedule for Vulcan South EA100265081 (Table 1)

11.4.8 - Eucalyptus cambageana woodland to open forest with Acacia harpophylla or A. argyrodendron on Cainozoic clay plains
Trees *Dominant: Acacia harpophylla, Eucalyptus cambageana* *Frequent: Eucalyptus cambageana, Acacia harpophylla, Eucalyptus populnea, Eucalyptus thozetiana, Terminalia oblongata subsp. Oblongata, Eremophila mitchellii, Lysiphyllum carronii* **Shrubs** *Dominant: Geijera parviflora, Acacia harpophylla, Eremophila mitchellii, Alectryon diversifolius, Carissa ovata* *Frequent*: *Eremophila mitchellii, Acacia harpophylla, Alectryon diversifolius, Carissa ovata, Atalaya hemiglauca, Flindersia dissosperma, Geijera parviflora, Apophyllum anomalum, Alphitonia excelsa, Capparis lasiantha, Clematicissus opaca, Enchylaena tomentosa, Eucalyptus cambageana, Terminalia oblongata* **Ground** *Dominant: Chloris ventricose, Enteropogon ramosus, Sporobolus scabridus, Paspalidium caespitosum, Trianthema triquetra* *Frequent Grasses: Sporobolus caroli, Enteropogon acicularis, Enteropogon ramosus, Cyperus gracilis, Eragrostis lacunaria, Sporobolus scabridus, Aristida personata, Chloris ventricose, Dactyloctenium radulans, Enneapogon lindleyanus, Paspalidium caespitosum, Ancistrachne uncinulata, Aristida indet., Aristida jerichoensis, Astrebla squarrosa, Cymbopogon refractus, Cyperus indet., Eriochloa pseudoacrotricha, Fimbristylis dichotoma, Heteropogon contortus, Panicum effusum, Paspalidium constrictum, Paspalidium distans*
11.5.3 - Eucalyptus populnea +/- E. melanophloia +/- Corymbia clarksoniana woodland on Cainozoic sand plains and/or remnant surfaces
Trees *Dominant: Eucalyptus populnea, Eucalyptus melanophloia* *Frequent: Eucalyptus populnea Eucalyptus melanophloia Eucalyptus brownii, Corymbia clarksoniana, Eucalyptus crebra, Ventilago viminalis, Eremophila mitchellii* **Shrubs** *Dominant: Eremophila mitchellii Erythroxylum australe, Grewia latifolia* *Frequent: Eremophila mitchellii, Erythroxylum australe, Grewia latifolia, Acacia excelsa, Atalaya hemiglauca, Carissa ovata, Eucalyptus populnea, Acacia sericophylla, Archidendropsis basaltica, Capparis lasiantha, Cassia brewsteri, Denhamia cunninghamii, Eucalyptus brownii, Eucalyptus melanophloia, Flindersia dissosperma, Lysiphyllum carronii, Psydrax oleifolia, Carissa lanceolata* **Ground** *Dominant: Themeda triandra, Aristida calycina, Chrysopogon fallax, Fimbristylis dichotoma* *Frequent Grasses: Chrysopogon fallax, Fimbristylis dichotoma, Heteropogon contortus, Aristida calycina, Digitaria brownii, Panicum effusum, Themeda triandra, Cyperus fulvus, Dichanthium sericeum, Eragrostis*

lacunaria, Eragrostis sororia, Aristida jerichoensis, Bothriochloa decipiens, Bothriochloa decipiens var. decipiens, Cymbopogon bombycinus, Cyperus gracilis, Digitaria ammophila, Enneapogon lindleyanus, Enneapogon virens, Eragrostis brownii, Eragrostis leptostachya, Eulalia aurea, Sporobolus caroli, Tragus australianus, Triodia pungens
11.10.1 - Corymbia citriodora woodland on coarse-grained sedimentary rocks
Trees *Dominant: Corymbia citriodora subsp. Citriodora, Corymbia citriodora subsp. Variegate, Eucalyptus crebra* *Frequent: Corymbia citriodora subsp. Variegate, Eucalyptus crebra, Corymbia citriodora subsp. Citriodora, Corymbia citriodora, Angophora leiocarpa, Eucalyptus fibrosa subsp. Nubilis, Eucalyptus longirostrata, Eucalyptus melanophloia* **Shrubs** *Dominant: Acacia leiocalyx subsp. Leiocalyx, Alphitonia excelsa* *Frequent: Acacia leiocalyx subsp. leiocalyx, Alphitonia excelsa, Corymbia citriodora subsp. Variegate, Eucalyptus crebra, Petalostigma pubescens, Acacia longispicata* **Ground** *Dominant: Cleistochloa subjuncea, Aristida indet., Eremochloa bimaculata, Arundinella nepalensis, Themeda triandra* *Frequent Grasses: Panicum effusum, Cymbopogon refractus, Arundinella nepalensis, Eremochloa bimaculata, Themeda triandra, Entolasia stricta, Fimbristylis dichotoma, Aristida caput-medusae, Scleria sphacelate, Aristida indet., Eragrostis elongata, Aristida ramosa, Cleistochloa subjuncea, Aristida queenslandica, Cyperus gracilis, Heteropogon contortus, Digitaria diffusa, Digitaria indet., Scleria mackaviensis, Chrysopogon fallax, Paspalidium criniforme, Digitaria breviglumis, Eulalia aurea, Setaria surgens, Sporobolus elongatus, Aristida calycina var. calycina, Aristida queenslandica var. queenslandica, Bothriochloa decipiens var. decipiens*
11.10.3 - Acacia catenulata or A. shirleyi open forest on coarse-grained sedimentary rocks. Crests and scarps
Trees *Dominant: Eucalyptus crebra, Acacia shirleyi, Alphitonia excelsa* *Frequent: Eucalyptus crebra, Corymbia citriodora, Acacia shirleyi* **Shrubs** *Dominant: Acacia shirleyi, Alphitonia excelsa* *Frequent: Alphitonia excelsa, Acacia shirleyi, Alstonia constricta, Erythroxylum sp. (Splityard Creek L.Pedley 5360), Erythroxylum australe* **Ground** *Dominant: Cleistochloa subjuncea Scleria sphacelate, Entolasia stricta, Eragrostis lacunaria, Thyridolepis xerophila* *Frequent: Aristida caput-medusae, Panicum effusum, Aristida queenslandica var. dissimilis, Entolasia stricta, Eragrostis lacunaria, Cleistochloa subjuncea Scleria sphacelate, Thyridolepis xerophila, Digitaria parviflora Eragrostis sororia, Setaria dielsii, Aristida gracilipes, Aristida jerichoensis var. subspinulifera, Cymbopogon refractus Digitaria ramularis, Paspalidium distans, Paspalidium gracile, Aristida jerichoensis var. jerichoensis, Calyptochloa gracillima subsp. gracillima, Cyperus gracilis, Digitaria breviglumis, Schoenus kennyi*
11.5.9 - Eucalyptus crebra and other Eucalyptus spp. and Corymbia spp. woodland on Cainozoic sand plains and/or remnant surfaces
Trees *Dominant: Eucalyptus crebra, Corymbia clarksoniana, Acacia leptostachya, Bursaria incana, Petalostigma banksii*

Frequent: Eucalyptus crebra, Corymbia clarksoniana, Casuarina cristata[1]*, Petalostigma pubescens, Acacia cowleana, Acacia leptostachya, Alphitonia pomaderroides Antidesma parvifolium, Bursaria incana, Gardenia indet., Geijera salicifolia Grevillea glauca, Larsenaikia ochreata, Petalostigma banksii Siphonodon indet.*

Shrubs

Dominant: Acacia conferta, Acacia disparrima subsp. Calidestris, Acacia cowleana, Gardenia indet., Petalostigma pubescens, Grewia retusifolia Petalostigma banksia, Eucalyptus crebra, Persoonia falcata
Frequent: Erythroxylum austral, Acacia conferta, Acacia cowleana, Acacia disparrima subsp. calidestris, Acacia holosericea, Alphitonia pomaderroides, Breynia oblongifolia, Coelospermum reticulatum, Gardenia indet., Grevillea parallela, Petalostigma pubescens, Eucalyptus crebra, Grewia retusifolia, Acacia leptostachya, Corymbia clarksoniana, Indigofera australis, Persoonia falcata, Petalostigma banksia

Ground

Dominant: Eremochloa bimaculate, Brunoniella acaulis, Desmodium brachypodum, Aristida holathera var. holathera
Frequent Grasses: Alloteropsis semialata Aristida calycina var. calycina, Chrysopogon fallax, Eragrostis spartinoides, Eremochloa bimaculata Panicum effusum, Ancistrachne uncinulata, Aristida holathera var. holathera, Calyptochloa cylindrosperma, Ectrosia indet., Heteropogon contortus, Mnesithea Formosa, Paspalidium indet., Scleria brownii, Themeda triandra

11.9.2 - Eucalyptus melanophloia +/- E. orgadophila woodland on fine-grained sedimentary rocks

Trees

Dominant: Eucalyptus orgadophila, Eucalyptus melanophloia
Frequent: Eucalyptus melanophloia Eucalyptus orgadophila, Acacia excelsa, Angophora subvelutina, Brachychiton populneus, Brachychiton populneus subsp. Populneus, Corymbia citriodora, Corymbia erythrophloia, Corymbia trachyphloia, Eremophila mitchellii, Eucalyptus populnea, Lysiphyllum carronii

Shrubs

Dominant: Carissa ovata Archidendropsis basaltica, Alectryon diversifolius, Ehretia membranifolia
Frequent: Alectryon diversifolius, Archidendropsis basaltica, Carissa ovata, Ehretia membranifolia, Atalaya hemiglauca, Breynia oblongifolia, Denhamia cunninghamii, Dodonaea filifolia, Eremophila mitchellii, Erythroxylum austral, Eucalyptus melanophloia, Geijera parviflora, Hovea longipes, Petalostigma pubescens, Senna indet., Xanthorrhoea glauca subsp. glauca

Ground

Dominant: Aristida calycina var. calycina, Enneapogon lindleyanus, Bothriochloa bladhii, Aristida indet.
Frequent Grasses: Enneapogon lindleyanus, Heteropogon contortus, Cymbopogon refractus, Themeda triandra, Ancistrachne uncinulata, Aristida calycina var. calycina, Aristida indet., Bothriochloa bladhii, Bothriochloa decipiens var. decipiens, Chloris ventricose, Cyperus indet., Enneapogon virens, Eragrostis lacunaria, Eulalia aurea, Panicum effusum, Paspalidium indet., Abildgaardia ovata, Aristida acuta, Aristida caput-medusae, Aristida holathera var. holathera, Aristida latifolia, Aristida leptopoda, Aristida personata, Bothriochloa bladhii subsp. bladhii, Bothriochloa ewartiana, Bulbostylis barbata, Chloris divaricate, Cyperus bifax, Cyperus gilesii, Cyperus gracilis, Dactyloctenium radulans Dichanthium sericeum subsp. sericeum, Digitaria indet., Enneapogon indet., Enneapogon polyphyllus, Enteropogon acicularis, Eragrostis indet., Eragrostis sororia, Eriochloa crebra, Eriochloa pseudoacrotricha, Heteropogon indet., Imperata cylindrica, Microlaena stipoides, Panicum decompositum, Paspalidium criniforme, Paspalidium distans, Paspalidium globoideum, Paspalidium gracile, Sarga leiocladum, Scleria brownii, Sporobolus caroli, Sporobolus creber, Themeda avenacea, Tragus australianus, Urochloa foliosa, Urochloa indet.

11.3.25 - Eucalyptus tereticornis or E. camaldulensis woodland fringing drainage lines

Trees

[1] *Casuarina cristata* is not listed in the technical description for 11.5.9; however, it has been included as it occurs locally and is an important species for the Glossy Black-cockatoo.

Dominant: Eucalyptus camaldulensis, Eucalyptus tereticornis, Corymbia tessellaris *Frequent: Eucalyptus tereticornis, Eucalyptus camaldulensis, Corymbia tessellaris, Angophora floribunda, Eucalyptus coolabah, Eucalyptus populnea, Acacia salicina, Acacia stenophylla* **Shrubs** *Frequent: Acacia salicina, Ficus opposite, Alphitonia excelsa, Melaleuca trichostachya* **Ground** *Dominant: Arundinella nepalensis, Heteropogon contortus, Themeda triandra, Lomandra longifolia* *Frequent grasses: Cyperus gracilis, Heteropogon contortus, Dichanthium sericeum subsp. sericeum, Paspalidium distans, Arundinella nepalensis, Bothriochloa bladhii subsp. bladhii, Cyperus indet., Paspalidium jubiflorum, Themeda triandra, Aristida personata, Eriochloa crebra, Chrysopogon filipes, Dichanthium sericeum, Eriochloa procera, Sporobolus mitchellii, Capillipedium spicigerum, Eulalia aurea, Imperata cylindrica, Leptochloa digitata, Panicum effusum, Anthosachne scabra, Bothriochloa bladhii, Cymbopogon refractus, Eragrostis leptostachya, Panicum laevinode, Sporobolus creber, Urochloa foliosa*
Low-intensity grazing
Grasses *Ancistrachne uncinate* *Bothriochloa ewartiana* *Chloris divaricate* *Chloris ventricose* *Cymbopogon refractus* *Dichanthium sericeum* *Themeda triandra* Japanese Millet - sterile hybrid Silk Sorghum

6.3.8 Rehabilitation Trials

A rehabilitation trial will not be conducted for the project considering the small period of time between the completion of works at the highwall and when the area is available for rehabilitation. If a rehabilitation trial was conducted, it would delay the onset of actual rehabilitation. To be of value, trials need to occur on remediated landforms, this could not occur until 2027. Learnings from Vulcan Coal Mine are anticipated to be far more valuable than a trial at Vulcan South.

7 SURRENDER OF THE ENVIRONMENTAL AUTHORITY

A surrender application must comply with requirements contained in section 262 of the *Environmental Protection Act 1994*. This application must be accompanied by a final rehabilitation report, a post-mining management report and a compliance statement for the EA and PRC Plan schedule.

The final rehabilitation report is to contain an environmental risk assessment and information on any proposed costs related to residual risks remaining at the site. The environmental risk assessment must be done using a methodology agreed to by the administering authority. The risk assessment is a key step before the calculation of any residual risk costs for the site. The calculation of costs could include consideration of the present value of the future costs of likely repairs, necessary monitoring and maintenance costs and the ongoing management costs of rehabilitated land.

There is a payment as a pre-condition to the surrender of an EA in order to allow the government to address residual risks associated with a site at surrender. Residual risks may include the possibility that rehabilitation works and engineered structures may fail or the ongoing costs of monitoring and maintenance after surrender.

The residual risk requirements do not remove or change the obligations of an EA holder to complete rehabilitation to required standards. The residual risk framework enables companies to relinquish the tenure and surrender an EA whilst ensuring the State understands any remaining risks on site and is resourced to manage the risks, including possible financial consequences of future environment harm.

8 RISK ASSESSMENT

In accordance with section 126C(1)(f) of the EP Act, this section assesses the risks of a stable PMLU not being achieved, and how these risks will be managed or minimised. Risks are scored based on definitions in **Table 8-1** Risks specific to each rehabilitation milestone have been identified in identified in **Table 8-2**. Both inherent risks (in the absence of risk treatments) and residual risks (once controls are in place) are identified and assessed for each hazard.

Table 8-1 Scoring system used to assess risks

			Likelihood				
			1 Rare	**2 Unlikely**	**3 Possible**	**4 Likely**	**5 Almost Certain**
			Unlikely to occur in a lifetime; or very unlikely to occur; or no known occurrences in broader worldwide community.	Could occur about once during a lifetime; or more likely not to occur than to occur; or has occurred at least once in the broader worldwide industry.	Could occur more than once during a lifetime; or as likely to occur as not to occur; or has occurred at least once in the mining/commodities trading industry.	May occur about once per year; or more likely to occur than not occur; or has occurred at least once on a mine site in the Bowen Basin.	May occur several times per year; or expected to occur; or has occurred several times on a mine site in the Bowen Basin.
Consequence	**5 Catastrophic**	Unconfined and widespread environmental damage; impacts reaching into surrounding areas; major remediation measures required.	**15**	**19**	**22**	**24**	**25**
	4 Major	Long-term (2-10 years) impact; major remediation measures required.	**10**	**14**	**18**	**21**	**23**
	3 Moderate	Medium-term (<2 years) impact; requires moderate intervention.	**6**	**9**	**13**	**17**	**20**
	2 Minor	Short-term impact; requires minor remediation or intervention.	**3**	**5**	**8**	**12**	**16**
	1 Negligible	No lasting impact; requires minor or no remediation; minor management intervention mat be required.	**1**	**2**	**3**	**7**	**11**

Table 8-2 Risk assessment for rehabilitation of Vulcan South

Milestone	Hazard	Impact	Inherent Risk			Proposed actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
1: Infrastructure decommissioning and removal.	Schedule for infrastructure decommissioning and removal inadequately communicated among management and work teams.	• Failure to remove all infrastructure in accordance with the PRC Plan Schedule. • Achievement of milestone 1 delayed.	2	3	9	• Infrastructure decommission schedule to be incorporated into annual mine planning. • Monthly progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding infrastructure decommissioning and removal. • A register of infrastructure is to track which structures exist in each rehabilitation area and which have been removed.	The proposed actions will allow the early identification of potential deviations from the PRC Plan Schedule, affording ample opportunity to adjust work rates to ensure that scheduled works are completed by the reporting date of 10 December.	Adequate time allocated for planning and progress meetings.	Refer to **Section 5.1**	Refer to **Section 9.1.1**	1	3	6
	Infrastructure decommissioning and removal takes longer than planned.	• Achievement of milestone 1 delayed.	2	2	5	• Monthly progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding infrastructure decommissioning and removal. • Additional work team resourcing may be sought in the event that the completion of scheduled works is otherwise unlikely by the annual reporting date.	The proposed actions will allow the early identification of potential deviations from the PRC Plan Schedule, affording ample opportunity to adjust work rates to ensure that scheduled works are completed by the reporting date of 10 December.	Adequate time allocated for planning and progress meetings; funding for supplementary contractors, if required.			1	2	3
2: Remediation of Contaminated Land	Previously unidentified contamination source discovered.	• Achievement of milestone 2 delayed. • Financial cost of remediation.	2	3	9	• Records are to be kept of all spills, leaks and other incidents occurring at the Project that might result in contamination. These incidents are to be recorded in an Incident Register, and information about relevant incidents are to be provided to an approved auditor prior to their site visit/testing. • Employees and contractors are to be made aware of their reporting obligations through a Site Induction. • Initial consultation with an approved auditor to identify contamination targets for remediation or removal.	To be suitable for a PMLU of low-intensity grazing, contaminated land must be removed from the Contaminated Land Register or the Environmental Management Register, and declared suitable for any use. These works must be approved by a suitably qualified person and an approved auditor (under the *Environmental Protection Act 1999* Act).	Adequate time per shift for reporting; funding for audits.	Refer to **Section 5.1**	Refer to **Section 9.1.2**.	1	3	6
	Remediation work not completed to schedule.	• Achievement of milestone 2 delayed, stalling later phrases of rehabilitation.	2	3	9	• Decontamination works are to be incorporated into annual mine planning. • Monthly progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding de-contamination works • Compliance with the PRC Plan schedule is to be overseen by responsible personnel.	Decontamination works must be completed to allow sufficient time for milestones 3 and 4 to be accomplished prior to the wet-season, or milestone 5 will be delayed by an additional year.	Adequate time allocated for planning and progress meetings.			1	3	6
	Waste rock is more reactive than anticipated.	• Potential for acid mine drainage, neutral metalliferous mine drainage or saline mine drainage to reduce water quality in groundwater and surface water. • High cost of remediation.	2	4	14	• Ongoing waste characterisation throughout operations. • Ongoing testing of mine-affected water throughout operations. • Should waste rock material with reactive chemistry be identified during operations: – Extraction is to cease until the situation can be resolved; and – Geochemical specialists are to be consulted to advise about appropriate handling and management of the material.	Ongoing testing of waste material and mine-affected water is a standard practice in QLD mining operations. It will provide an early detection system for mischaracterisation of rock. A response procedure will aim to prevent further removal of reactive material until appropriate infrastructure can be designed and constructed to manage the material.	Adequate budget for geochemical testing.			1	4	10
3: Landform Development and Reshaping/Reprofiling	Heavy rain prior to surface preparation and revegetation (milestones 4 and 5).	• Sedimentation of downstream waterways.	4	3	17	• Slope designed with shallow gradient. • Earthworks timed to coincide with dry-season. • Sediment management systems (drains and sediment dams) to be operational during construction of final landform.	The planned low slope gradient limits the capacity for water to carry material. Heavy downpours are unlikely between the months of June and October. Sediment management systems trap eroded material before it can enter local waterways. This system has been designed in accordance with the *Best Practice Erosion and Sediment Control* (IECA 2008) guidelines.	The sediment management system has been already designed for the planning and approval stages of the Project. Appropriate time and personnel are required for construction of this system.	Refer to **Section 5.1**	Refer to **Section 9.1.3**.	2	3	9
	Timing and design specifications for final landform not adequately implemented.	• Achievement of milestone 3 delayed. • Reduced safety and/or stability of final landform.	2	3	9	• Annual audits are to confirm agreement between as-constructed landforms and approved designs. • Monthly progress meetings are to take place between management (i.e., responsible personnel) and work crews regarding landform construction.	Early detection of inconsistencies between constructed landforms and approved designs will allow adequate opportunity for modifications to be completed by the reporting date of 10 December.	Adequate time allocated for planning and progress meetings; funding for auditors.			1	2	3
4: Surface preparation	Inappropriate topsoil and subsoil management whilst stockpiled.	• Reduced viability of topsoil, limiting plant establishment at rehabilitated sites. • Topsoil infested with weed propagules, which will invade rehabilitated sites.	4	4	21	• Spatial segregation of topsoil and subsoil, with signage installed at each stockpile to denote soil type. • Topsoil stockpiles to be managed in strict accordance with practices described in **Section 6.3.4.**	By minimising stockpile heights, preventing the mixing of subsoils and topsoil, maintaining a vegetative cover on stockpiles and controlling weed populations on stockpiles before they become dominant, soil health will be maintained.	Adequate signage, herbicides and personnel are required.	Refer to **Section 5.1**	Refer to **Section 9.1.4**.	2	3	9

Milestone	Hazard	Impact	Inherent Risk			Proposed actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
	Inadequate topsoil cover	• Exposure of dispersive subsoils to rain. • Gully erosion. • Cost of repeating landform reshaping and surface preparation.	3	4	18	• A minimum of 25 cm of topsoil is to be placed on all exposed subsoil. • 30% rock cover applied to topsoil on slopes. • Subsoils are to be mixed with 25% rock. • Rapidly establishing grasses to be included in seed-mixes. • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation.	Dispersive subsoils across the local region often naturally have a cover of only 10-20 cm of stable topsoil, and 25 cm is considered sufficient to protect the subsoil from exposure to erosional forces. A review of studies elsewhere in the Bowen Basin (refer **Section 6.2.8**) indicates that the measures in place at the Project will sufficiently limit the risk of erosion.	Adequate waste rock set aside for a protective cover; seed for pioneer grasses; appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.			2	3	9
	Vehicles contaminated with weed seeds used for earthworks	• Weeds invading rehabilitated sites, inhibiting the establishment of desirable species and preventing achievement of milestones 6 and 7.	3	4	18	• Strict vehicle wash-down practices for vehicles entering the site from contaminated areas. • Annual weed monitoring program, to allow the early detection and treatment of new weed infestations.	Prevention of introduction and early treatment of new infestations are central to the successful and cost-effective management of weeds on site.	Adequate time and budget for wash-downs, monitoring and weed control.			2	3	9
	Heavy rainfall occurring prior to establishment of vegetative cover.	• Loss of topsoil from slopes. • Siltation of downstream waterways. • Failure of vegetation to establish on eroded surfaces. • Cost of reapplying topsoil to eroded surfaces.	4	3	17	• Low slope gradient in landform design to limit capacity for sediment loss. • Surface preparation immediately prior to seeding to limit time that bare slopes are exposed to rain events. • 30% rock cover applied to slopes. • Rapidly establishing grasses to be included in seed-mixes. • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation.	A review of studies elsewhere in the Bowen Basin (refer **Section 6.2.8**) indicates that the measures in place at the Project will sufficiently limit the risk of erosion.	Adequate waste rock set aside for a protective cover; seed for pioneer grasses; appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.			2	3	9
5: Revegetation	Seed unavailable	• Lack of seed of certain species can lead to long-term effects on the composition of the eventual plant communities that establish.	4	3	17	• Seed collection and procurement is to commence at the start of the Project, so that supplies are available when revegetation begins. • A store of seed is to be maintained on site. • Woody species unavailable at the time of sowing are to be added to rehabilitated sites as tubestock in the following wet season.	Approximately half of the species to be used are not currently stocked by commercial seed suppliers and therefore require local collection. Collecting over two years prior to revegetation allows for certain species to seed poorly in any one year.	Funding for seed collection/purchase must be available from the start of the Project.	Refer to **Section 5.1**	Refer to **Section 9.1.5**.	2	2	5
	Heavy rain immediately after sowing	• Loss of topsoil from slopes. • Siltation of downstream waterways. • Failure of vegetation to establish on eroded surfaces. • Cost of reapplying topsoil to eroded surfaces.	4	3	17	• Low slope gradient in landform design to limit capacity for sediment loss. • Surface preparation and sowing is not to take place if heavy rain (>40 mm) is forecast over any one day within the next fortnight. • 30% rock cover applied to slopes during surface preparation. • Rapidly establishing grasses to be included in seed-mixes. • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation.	A review of studies elsewhere in the Bowen Basin (refer **Section 6.2.8**) indicates that the measures in place at the Project will sufficiently limit the risk of erosion.	Adequate waste rock set aside for a protective cover; seed for pioneer grasses; appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.			2	3	9
	Inappropriate quantity of grass seed used in the seed mix	• Tree and shrub establishment inhibited by high grass cover. • Insufficient protective cover of grass increasing the risk of erosion.	3	3	13	• Seed mixes have been based on other mine sites across north-eastern Australia. • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • In sites with excessive grass densities, tubestock of trees and shrubs are to be planted within circles (1 m radius) of grass that have been killed using herbicide. • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth.	Studies elsewhere in the Bowen Basin indicate that dense grass can inhibit vegetation development (Erskine and Fletcher 2013). Early identification of issues and amendments of seed mixes will reduce overall costs associated with remediating over- or under-dense grass swards.	Adequate time for reviewing the revegetation methodology on an annual basis.			2	2	5

Milestone	Hazard	Impact	Inherent Risk			Proposed actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
	Inappropriate quantity of tree and shrub seed used in the seed mix	• Insufficient or excessive canopy cover can cause the eventual vegetative communities to fail to achieve milestones 6 and 7.	3	3	13	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Supplementary planting of tubestock or thinning of established seedlings may be required to correct for inappropriate tree densities.	A minimum tree and shrub density is required to achieve completion criteria pertaining to the Koala, Squatter Pigeon, Glossy Black-Cockatoo and Greater Glider. However, excessive tree and shrub densities limit pasture development, jeopardising the achievement of the desired PMLU. Early identification of issues and amendments of seed mixes will reduce overall costs associated with remediating over- or under-dense grass swards.	Adequate time for reviewing the revegetation methodology on an annual basis.			2	2	5
	Topsoil quality being unsuitable for plant establishment.	• Poor seedling survival and establishment.	4	3	17	• Testing soil prior to use in rehabilitation • Amelioration strategies at the time of planting will facilitate plant establishment and growth.	Dispersity and nutrients deficiency is a potential problem with a portion of the project areas topsoil for use in rehabilitation. Nutrients levels naturally decline following extended periods of soil stockpiling. For these reasons, testing the soil prior to use in rehabilitation, especially if it was stockpiled for a period of time, is essential. In addition, soil amelioration strategies will be used prior to the use in rehabilitation.				2	2	5
	Drought over the first months after planting	• Poor seedling survival and establishment.	3	3	13	• Planting is to take place in the early wet season, when probability of further rain during seedling establishment is high. • Supplementary planting (seed or tubestock) may be required following exceptionally dry years.	Long dry periods soon after germination can result in widespread mortality of seedlings. The proposed actions reduce the risk of this occurring and propose remedial actions in the event it does occur.	Adequate time and budget allocated for planting in years following drought.			3	2	8
	Vehicles and/or footwear contaminated with weed seeds	• Weeds invading rehabilitated sites, inhibiting the establishment of desirable species and preventing achievement of milestones 6 and 7.	3	4	18	• Strict vehicle wash-down practices for vehicles entering the site from contaminated areas. • Annual weed monitoring program, to allow the early detection and treatment of new weed infestations.	Prevention of introduction and early treatment of new infestations are central to the successful and cost-effective management of weeds on site.	Adequate time and budget for wash-downs, monitoring and weed control.			2	3	9
	Intruding livestock	• Premature grazing could lead to poor seedling establishment.	4	3	17	• Cattle-proof fencing surrounding each rehabilitation area is to be installed prior to seeding. • Fences are to be inspected monthly, faults immediately repaired and livestock immediately removed.	Rehabilitated areas are to be maintained free of livestock until vegetation is adequately established (at least five years).	Fencing materials and personnel for construction and inspection.			1	1	1
6: Commencement of Grazing	Poor pasture development	• Insufficient pasture density to meet completion criteria. • Insufficient species richness of grasses to meet completion criteria. • Increased risk of erosion.	3	3	13	• Seed mixes have been based on other mine sites across north-eastern Australia. • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth.	Early identification of issues and amendments of seed mixes will reduce overall costs associated with remediating over- or under-dense grass swards.	Adequate time for reviewing the revegetation methodology on an annual basis; additional seed stocks and fertiliser, as required.	Refer to **Section 5.1**	Refer to **Section 9.1.6**	2	2	5
	Weeds	• Weeds invading rehabilitated sites, inhibiting the establishment of desirable species and preventing achievement of milestones 6, 7 and 8.	3	4	18	• Strict vehicle wash-down practices for vehicles entering the site from contaminated areas. • Annual weed monitoring program, to allow the early detection and treatment of new weed infestations.	Prevention of introduction and early treatment of new infestations are central to the successful and cost-effective management of weeds on site.	Adequate time and budget for wash-downs, monitoring and weed control.			2	3	9
	Excessive density of trees and shrubs	• Pasture species become shaded out. • Failure to achieve targets of rehabilitation completion criteria.	3	2	8	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Thinning of woody vegetation (using machinery or fire) may be required at sites with excessive shrub and tree densities.	Early refinements of the seed mixes will reduce the need for later interventions. Vegetation thinning is widely implemented in Queensland's pastoral landscapes to increase pasture production in densely forested situations.	Adequate time for reviewing the revegetation methodology on an annual basis; machinery to undertake thinning of trees and shrubs, if required.			1	2	3

Milestone	Hazard	Impact	Inherent Risk			Proposed actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
7: Establishment of target vegetation in non-riparian areas	Poor development of Koala, Glossy Black-Cockatoo and Greater Glider food trees	• Insufficient density of food trees to allow use of rehabilitated areas by the Koala, Glossy Black-Cockatoo and Greater Glider. • Failure to achieve targets of completion criteria. • Failure to achieve BioCondition targets	2	4	14	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Regular monitoring aims for the early detection of sites with inadequate seedling establishment. • Sites with insufficient density of food trees developing over the first two years will undergo supplementary planting of tubestock.	Early refinements of the seed mixes will reduce the need for later interventions. Tubestock is a superior method for adding trees to existing pastures, as tree seeds often fail to germinate/establish among competitive understorey species.	Adequate time for reviewing the revegetation methodology on an annual basis; a nursery facility to rear tubestock OR contracts with commercial nurseries to rear stock.	Refer to **Section 5.1**	Refer to **Section 9.1.7**	2	2	5
	Excessive density of trees and shrubs	• Habitat becomes unsuitable for the Squatter Pigeon. • Failure to achieve targets of rehabilitation completion criteria.	3	2	8	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Thinning of woody vegetation (using machinery or fire) may be required at sites with excessive shrub and tree densities.	Early refinements of the seed mixes will reduce the need for later interventions.	Adequate time for reviewing the revegetation methodology on an annual basis; machinery to undertake thinning of trees and shrubs, if required.			1	2	3
	Insufficient density of trees and shrubs	• Habitat is unsuitable for the Koala and Squatter Pigeon. • Failure to achieve targets of rehabilitation completion criteria.	3	4	18	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Regular monitoring aims for the early detection of sites with inadequate seedling establishment. • Sites with insufficient density of trees and shrubs developing over the first two years will undergo supplementary planting of tubestock.	Early refinements of the seed mixes will reduce the need for later interventions. Tubestock is a superior method for adding trees to existing pastures, as tree seeds often fail to germinate/establish among competitive understorey species.	Adequate time for reviewing the revegetation methodology on an annual basis; a nursery facility to rear tubestock OR contracts with commercial nurseries to rear stock.			2	2	5
	Weeds	• Weeds could invade via wind, vehicles or footwear during vegetation development. • Weeds can inhibit the establishment of desirable species and preventing achievement of milestones 6 and 7.	2	4	14	• Strict vehicle wash-down practices for vehicles entering the site from contaminated areas. • Annual weed monitoring program, to allow the early detection and treatment of new weed infestations.	Prevention of introduction and early treatment of new infestations are central to the successful and cost-effective management of weeds on site. Weed risk is highest during topsoil stockpiling, surface preparation and planting, rather than during the development of the vegetation communities post-planting. However, weed management practices are to remain in place throughout the duration of rehabilitation.	Adequate time and budget for wash-downs, monitoring and weed control.			2	3	9
	Fire	• A fire during early stages of vegetation establishment could kill developing trees and shrubs prior to their establishment, leading to a failure to achieve rehabilitation completion criteria pertaining to tree cover.	2	3	9	• A fire break will be maintained along the western boundary of the Project, to minimise the risk of fires originating within bushland areas of the Harrow Range. • An Emergency Response Plan describes processes in place to control fires that originate on site.	Damaging fires are most likely to spread from the west, due to the large tracts of bushland present there and the hot, dry westerly winds typically associated with periods of high fire risk. Close proximity of the in-pit dump to Saraji Road precludes the installation of fire breaks along the eastern boundary of rehabilitated land (maintaining a strip of bare ground on the foot-slopes of the in-pit dump poses too high an erosion risk).	Personnel and machinery required to build and maintain fire breaks.			1	3	6
	Intruding livestock	• Premature grazing could damage developing trees and shrubs	4	3	17	• Fences are to be inspected monthly, faults immediately repaired and livestock immediately removed.	Rehabilitated areas are to be maintained free of livestock until vegetation is adequately established (at least five years).	Personnel for inspections and repairs; tools and equipment for fencing.			1	1	1
	Flooding	• Damage caused to water infrastructure	2	3	9	• Flood gates across waterways will also need to be inspected after runoff events to inspect for fence integrity.	Early identification of damage will prevent further deterioration of key water infrastructure	Personnel for inspections and repairs; tools and equipment			1	1	1
8: Establishment of target vegetation in riparian areas	Poor development of Koala, Glossy Black-Cockatoo and Greater Glider food trees	• Insufficient density of food trees to allow use of rehabilitated areas by the Koala, Glossy Black-Cockatoo and Greater Glider. • Failure to achieve targets of completion criteria.	2	4	14	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Regular monitoring aims for the early detection of sites with inadequate seedling establishment. • Sites with insufficient density of food trees developing over the first two years will undergo supplementary planting of tubestock.	Early refinements of the seed mixes will reduce the need for later interventions. Tubestock is a superior method for adding trees to existing pastures, as tree seeds often fail to germinate/establish among competitive understorey species.	Adequate time for reviewing the revegetation methodology on an annual basis; a nursery facility to rear tubestock OR contracts with	Refer to **Section 5.1**	Refer to **Section 9.1.8**	2	2	5

Milestone	Hazard	Impact	Inherent Risk			Proposed actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
		• Failure to achieve BioCondition targets for RE 11.3.25						commercial nurseries to rear stock.					
	Insufficient density of trees and shrubs	• Habitat is unsuitable for the Koala and Squatter Pigeon. • Failure to achieve targets of rehabilitation completion criteria.	3	4	18	• Seed mixes have been based on other mine sites across north-eastern Australia. • Seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • Regular monitoring aims for the early detection of sites with inadequate seedling establishment. • Sites with insufficient density of trees and shrubs developing over the first two years will undergo supplementary planting of tubestock.	Early refinements of the seed mixes will reduce the need for later interventions. Tubestock is a superior method for adding trees to existing pastures, as tree seeds often fail to germinate/establish among competitive understorey species.	Adequate time for reviewing the revegetation methodology on an annual basis; a nursery facility to rear tubestock OR contracts with commercial nurseries to rear stock.			2	2	5
	Weeds	• Weeds could invade via wind, vehicles or footwear during vegetation development. • Weeds can inhibit the establishment of desirable species and preventing achievement of milestones 6 and 7.	2	4	14	• Strict vehicle wash-down practices for vehicles entering the site from contaminated areas. • Annual weed monitoring program, to allow the early detection and treatment of new weed infestations.	Prevention of introduction and early treatment of new infestations are central to the successful and cost-effective management of weeds on site. Weed risk is highest during topsoil stockpiling, surface preparation and planting, rather than during the development of the vegetation communities post-planting. However, weed management practices are to remain in place throughout the duration of rehabilitation.	Adequate time and budget for wash-downs, monitoring and weed control.			2	3	9
	Fire	• A fire during early stages of vegetation establishment could kill developing trees and shrubs prior to their establishment, leading to a failure to achieve rehabilitation completion criteria pertaining to tree cover.	2	3	9	• A fire break will be maintained along the western boundary of the Project, to minimise the risk of fires originating within bushland areas of the Harrow Range. • An Emergency Response Plan describes processes in place to control fires that originate on site.	Damaging fires are most likely to spread from the west, due to the large tracts of bushland present there and the hot, dry westerly winds typically associated with periods of high fire risk. Close proximity of the in-pit dump to Saraji Road precludes the installation of fire breaks along the eastern boundary of rehabilitated land (maintaining a strip of bare ground on the foot-slopes of the in-pit dump poses too high an erosion risk).	Personnel and machinery required to build and maintain fire breaks.			1	3	6
	Intruding livestock	• Premature grazing could damage developing trees and shrubs and impair pasture development.	4	3	17	• Fences are to be inspected monthly, faults immediately repaired and livestock immediately removed.	Rehabilitated areas are to be maintained free of livestock until vegetation is adequately established (at least five years).	Personnel for inspections and repairs; tools and equipment for fencing.			1	1	1
	Flooding	• Damage caused to water infrastructure	2	3	9	• Flood gates across waterways will also need to be inspected after runoff events to inspect for fence integrity.	Early identification of damage will prevent further deterioration of key water infrastructure	Personnel for inspections and repairs; tools and equipment.			1	1	1
	Soil	• Soil testing may not meet targets	3	4	18	• Soil amelioration techniques will be utilised. These may include: • Addition of 1 t/ha of lime (incorporated in the first 10 cm of soil) to increase the pH of sandy soils. This will be followed up with further pH testing to evaluate the need to add more lime – lime would be added initially at small doses and then at gradually increasing application rates as necessary. • application of 5 t/ha of gypsum to improve exchangeable sodium percentage levels. • Additional irrigation of soil so that sodium moves down the soil profile.	Early identification will prevent further deterioration of soil.	Soil testing equipment, access to soil. ameliorants, irrigation equipment.			2	2	5
9 Achievement of native ecosystem land use with a stable condition	Poor landscape stability	Failure of sites to develop adequate sediment and leaf litter capture by groundcover features. • Formation of a dysfunctional landscape that results in a loss of resources (nutrients, water, sediment) over the long term. • Failure to achieve rehabilitation completion criteria pertaining to land stability.	2	3	9	• Low slope gradient in landform design to limit capacity for sediment loss. • 30% rock cover applied to slopes during surface preparation. • Inclusion of a diversity of grass, trees and shrubs in seed mixes. • Topsoil storage and handling are to be in accordance with practices described in **Section 6.3.4.**	Landscape function analysis is a widely implemented framework for managing and monitoring landscape stability. A review of studies elsewhere in the Bowen Basin (refer **Section 6.2.8**) indicates that the measures in place at the Project will lead to a stable landform with low erodibility.	Personnel/contractors required for regular monitoring; adequate time for reviewing the revegetation methodology on an annual basis; additional seed stocks and fertiliser, as required.	Refer to **Section 5.1**	Refer to **Section 9.1.9**	2	2	5

Milestone	Hazard	Impact	Inherent Risk			Proposed actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
	Significant erosion of placed soils on final landform	• Failure to establish vegetative cover and therefore stable PMLU • Loss of topsoil • Loss of sediment control structure performance • Water quality impacts	4	3	17	• Low slope gradient in landform design to limit capacity for sediment loss. • Surface preparation and sowing is not to take place if heavy rain (>40 mm) is forecast over any one day within the next fortnight. • 30% rock cover applied to slopes during surface preparation. • Rapidly establishing grasses to be included in seed-mixes. • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation. • Amelioration measures to assist with soil retention, including addition of: ○ fertiliser; and • organic mulch.	A review of studies elsewhere in the Bowen Basin (refer **Section 6.2.8**) indicates that the measures in place at the Mine will sufficiently limit the risk of erosion. Further amelioration measures are provided to enhance early establishment of vegetation and to support a sustainable and productive vegetative cover.	Adequate waste rock set aside for a protective cover; seed for pioneer grasses; amelioration materials and labour; appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.			2	3	9
10 Achievement of cattle grazing land use with stable condition	Low pasture productivity.	• Failure to support economically viable cattle grazing.	2	3	9	• Seed mixes have been based on other mine sites across north-eastern Australia. • Grass seed application rates are to be modified pending the outcome of the initial rounds of rehabilitation. • In sites with insufficient grass cover, there is to be supplementary sowing and/or fertilising in bare patches to encourage grass growth.	Early identification of issues and amendments of seed mixes will reduce overall costs associated with remediating inadequate grass cover.	Personnel/contractors required for regular monitoring; adequate time for reviewing the revegetation methodology on an annual basis; additional seed stocks and fertiliser, as required.	Refer to **Section 5.1**	Refer to **Section 9.1.10**	2	2	5
	Low pasture diversity.	• Over-dominance of one or few pasture species increases the vulnerability of the pasture to extreme environmental events (flood, fire, drought, insect plagues). • Low pasture diversity is associated with reduced nutrient cycling and ecosystem stability. • Failure to sustain cattle grazing in the long-term.	4	4	23	• A multitude of local pasture species are to be included in seed-mixes. • Non-native grasses known to suppress other species (e.g., Buffel Grass) are to be sown at very low rates. • Regular monitoring (every two years) of rehabilitated sites will track pasture diversity and allow for an early modification of seed mixes and/or other interventions.	Over-dominance of Buffel Grass limits rehabilitation success and stability at other Bowen Basin mines (Erskine and Fletcher 2013). It is important to allow less aggressive grass species time to establish prior to Buffel Grass becoming too dense. A diversity of grasses improves ecosystem stability and protects against fluctuations in environmental conditions.	Personnel/contractors required for regular monitoring; adequate time for reviewing the revegetation methodology on an annual basis; additional seed stocks and fertiliser, as required.			2	4	14
	Poor landscape function.	• Failure of sites to develop adequate sediment and leaf litter capture by groundcover features. • Formation of a dysfunctional landscape that results in a loss of resources (nutrients, water, sediment) over the long term. • Failure to achieve rehabilitation completion criteria pertaining to landscape function.	2	3	9	• Low slope gradient in landform design to limit capacity for sediment loss. • 30% rock cover applied to slopes during surface preparation. • Inclusion of a diversity of grass, trees and shrubs in seed mixes. • Topsoil storage and handling are to be in accordance with practices described in **Section 6.3.4.**	Landscape function analysis is a widely implemented framework for managing and monitoring landscape stability. A review of studies elsewhere in the Bowen Basin (refer **Section 6.2.8**) indicates that the measures in place at the Mine will lead to a stable landform with low erodibility.				2	2	5
	Significant erosion of placed soils on final landform	• Failure to establish vegetative cover and therefore stable PMLU • Loss of topsoil • Loss of sediment control structure performance • Water quality impacts	4	3	17	• Low slope gradient in landform design to limit capacity for sediment loss. • Surface preparation and sowing is not to take place if heavy rain (>40 mm) is forecast over any one day within the next fortnight. • 30% rock cover applied to slopes during surface preparation. • Rapidly establishing grasses to be included in seed-mixes. • Sediment management systems (drains and sediment dams) to be operational during surface preparation and revegetation. • Amelioration measures to assist with soil retention, including addition of: ○ fertiliser; and • organic mulch.	A review of studies elsewhere in the Bowen Basin (refer **Section 6.2.8**) indicates that the measures in place at the Mine will sufficiently limit the risk of erosion. Further amelioration measures are provided to enhance early establishment of vegetation and to support a sustainable and productive vegetative cover.	Adequate waste rock set aside for a protective cover; seed for pioneer grasses; amelioration materials and labour; appropriate time and personnel are required for construction of the sediment management system and final landform according to designs.			2	3	9

Milestone	Hazard	Impact	Inherent Risk			Proposed actions	Justification of treatment option	Resource requirements	Performance measures	Reporting and monitoring	Residual Risk		
			Likelihood	Consequence	Risk Ranking						Likelihood	Consequence	Risk Rating
11: Acceptance of Saraji Road by Isaac Regional Council	The Saraji Road realignment does not meet the requirements of IRC and will not be accepted.	• Cost of repairs • Delays to the commencement of mining, due to the retention of the old road until the new one is accepted.	3	4	18	• Adherence to a legal agreement with IRC outlining the requirements and responsibilities of all parties to facilitate the construction, maintenance and eventual handover of the road realignment. • Road inspections at the direction of IRC. • Ability of IRC to direct Vitrinite to undertake remediation in a timely fashion. • Security held by IRC for the purpose of undertaking any remediation that Vitrinite fails to complete. • Requirement of a Certificate of Practical Completion prior to return of the Road to IRC. • A 12-month Defects Period during which Vitrinite remains responsible for any remediation that is required prior to IRC assuming maintenance responsibility.	As a functioning council road that is intended to remain in place in perpetuity, Saraji Road must meet regional council requirements in its construction and maintenance. The construction and maintenance of the Saraji Road Realignment is the only rehabilitation that is appropriate to this area as a piece of remaining infrastructure.	Provision of security and any associated management documents to IRC for approval prior to commencement. Resources appropriate to road maintenance and all other aspects of the agreement with IRC until such time that the agreement is ended	Refer to **Section 5.1**	Refer to **Section 9.1.11**	2	3	9

9 MONITORING

9.1 Milestone Monitoring

Nine rehabilitation milestones are described in the PRC Plan Schedule. A monitoring program has been developed to determine whether milestone criteria have been achieved. This program is described below, with respect to each of the rehabilitation milestones.

9.1.1 Rehabilitation Milestone 1: Infrastructure Decommissioning and Removal

Following the disconnection of services and removal of all buildings and mine infrastructure, an Infrastructure Decommissioning Checklist is to be completed. Failure of a site to meet all items on the checklist will trigger remedial works to remove outstanding infrastructure. This rehabilitation milestone monitoring is applicable to rehabilitation areas RA6, RA7, RA8, RA9 and RA10. An example checklist is provided below in **Figure 9-1.** Further detail on the milestone criteria set for the decommissioning and removal of infrastructure is provided in **Section 10.3**. This includes a list identifying how infrastructure will be decommissioned.

Infrastructure Decommissioning Checklist

Name of Auditor:_____Date:_____

Rehabilitation Area:_____

Total Hectares Decommissioned:_____

Yes	No	N/A	
☐	☐	☐	Have all services been disconnected?
☐	☐	☐	Have all road materials (bitumen, gravel) been removed?
☐	☐	☐	Have all pipelines been drained and removed?
☐	☐	☐	Have all fences that do not form part of the post-mining land use been removed?
☐	☐	☐	Have all buildings been removed?
☐	☐	☐	Have all machinery and equipment been removed?
☐	☐	☐	Have all unnecessary surface water infrastructure and drainage been removed?
☐	☐	☐	Has all rubbish been removed?

If 'No' was selected for any of the above questions, provide a description of the works remaining to be undertaken:

_____

_____

_____

_____

_____

_____

Figure 9-1 Example Infrastructure Decommissioning Checklist

9.1.2 Rehabilitation Milestone 2: Remediation of Contaminated Land

A contaminated land investigation document is to be prepared by an approved auditor, which is to contain the following components:

- a site investigation report, scientifically assessing whether contamination exists;
- a validation report, describing works undertaken to remediate any contamination; and
- a site suitability statement, stating that land is not contaminated and is suitable for any use.

Rehabilitation areas for which this milestone may be relevant include RA4, RA5, RA6, RA7, RA8, RA9 and RA10.

9.1.3 Rehabilitation Milestone 3: Landform Development and Reshaping/Reprofiling

Following landform development and reprofiling, inspection and reporting is required to provide assurance that rehabilitation activities occurred in accordance with approved designs. Upon the completion of physical works, all landform works must have 'as-constructed' plans prepared. Deviations between design and construction are to be identified and highlighted. A database of design and 'as-constructed' plans for any engineering works associated with the mine rehabilitation is to be maintained.

Rehabilitation areas requiring landform development include RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA10.

9.1.4 Rehabilitation Milestone 4: Surface Preparation

Soil assessments are to be undertaken of stockpiled topsoil within the six months prior to spreading. Soil is to be sampled at various depths of each stockpile. These tests are to be carried out by an appropriately qualified person to confirm that soil is suitable for target vegetation establishment.

As a record of milestone completion, GIS files should be kept that record:

- the boundaries of each area that had topsoil applied in each year (areas with different soil management units or topsoil spreading methodology are to be mapped separately);
- the date on which topsoil spreading occurred in each area;
- depth of topsoil applied in each area;
- the soil management unit of the topsoil applied in each area; and
- whether rock mulch was applied.

These records are to be kept wherever topsoil is spread, including in rehabilitation areas RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA10.

Any erosion classified as 'moderate' or 'severe' as defined in **Table 9-1** framework, that occurs after the achievement of RM3, has been remediated prior to topsoil application.

9.1.5 Rehabilitation Milestone 5: Revegetation

All areas in which seeding and planting have been carried out are to be entered into a GIS database that includes the following details:

- the boundaries of each area rehabilitated (areas with different soil management units, seed mixes or dates of planting are to be mapped separately);
- the soil management unit of the topsoil applied in each area;
- the seed mix applied to each area;
- the date the seed mix was applied to each area;

- the number and species of tubestock planted in each area; and
- the date tubestock was planted.

These records are to be kept wherever planting takes place, including in rehabilitation areas RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA10.

9.1.6 Rehabilitation Milestone 6: Land Suitable for the Commencement of Grazing

Monitoring of milestone RM6 involves a combination of field surveys and satellite imagery analysis. Methodologies for each are described below. Rehabilitation areas requiring assessment of suitability for the commencement of grazing include RA2, RA5, RA7 and RA9.

Erosion Monitoring

Erosion monitoring across the landform will be undertaken for the early detection of erosion, to allow for early intervention.

In-field erosion monitoring will be undertaken at permanent monitoring transects, (50 m in length) established across the landform in conjunction with the LFA monitoring sites. Visual observations will be taken whilst traversing transects on foot and recording the number and average depth of any erosion features, rill lines or gullies. Visual assessments should identify evidence of excessive sediment movement, including the formation of rills, removal of soil around the base of plants and accumulation of loose sediment at the base of slopes. In-field erosion monitoring will be accompanied by assessment of the water quality of run-off water released from the catchment of given rehabilitation areas.

Any erosion classified as 'moderate' or 'severe' as defined in **Table 9-1** framework has been remediated.

Erosion monitoring methodology is further detailed in Section 9.6 of the **Vulcan South Soils and Land Suitability Assessment** (**Appendix C**).

Table 9-1 Erosion classification framework

Erosion classification	Minor	Moderate	Severe
Sheet erosion	Shallow soil deposits downslope.	Partial exposure of roots; moderate soil deposits downslope.	Loss of surface horizon; subsoil exposure; root exposure; substantial soil deposits downslope.
Rill/gully erosion	<15 rills and <0.3m deep	15-30 rills and <0.3m deep	>30 rills and/or any >0.3m deep
Tunnel erosion	Absent	Absent	Present
Mass movement	Absent	Absent	Present

Source: NCST (2009) *Australian Soil and Land Survey Field Handbook, 3rd edition*. The National Committee on Soil and Terrain. CSIRO Publishing, Collingwood, Australia.

Ground Cover

An accurate measurement is required to assess the rehabilitation completion criteria that "grazed land maintains a percentage ground cover of between 50% and 96%". While this criteria relates specifically to rehabilitation areas to which cattle have been introduced (at advanced stages of rehabilitation development), it is prudent to commence this monitoring prior to the introduction of cattle. This data can then be used to calculate the effect of

grazing on percentage cover, and thereby predict the groundcover expected at ungrazed sites following cattle introduction. This in turn will be useful for adjusting stocking rates, if required.

Ground cover is to be calculated by running a 50 m measuring tape along the length of each vegetation monitoring transect. Observations of the type of cover (limited to the cover present below 1 m above ground level) are made at point intercepts along the centre line of the 50 m transect at 0.5 m intervals. Cover types include (a) vegetation (including all live vegetation and standing senescent vegetation that is still attached to the main plant and is not in intimate contact with the soil); (b) leaf litter and woody debris; (c) rock or (d) bare ground. The cover type that is intercepted directly below each point is recorded. The intercept point is to be assessed by viewing the ground through a small observation hole (in a piece of stiff card or plastic) or tube. Preferably, this should contain a cross hair, although this is not obligatory. A total of 100 observations are made per transect, and the sum of each cover type equates to its percentage cover.

Percentage cover is to be assessed at rehabilitation sites only (reference site data is not required). Monitoring is to be undertaken concurrently with assessments of landscape function and vegetation surveys in the late wet season.

Pasture Productivity

For PLMU of cattle grazing, pasture productivity within rehabilitated sites is to be equivalent to nearby unmined sites on the same soil types. Pasture productivity is to be assessed via one of two methods:

1) **Manual measurements of pasture mass at specific moments in time.** An electronic dry matter capacitance meter (e.g., Grassmaster Pro) can be used to estimate pasture dry mass (kg/ha) at points within rehabilitation areas. This technique is superior to traditional plate meters on stony ground, such as will be found on sloping rehabilitation areas. The exact number of replicate points required per rehabilitation area is dictated by the variation observed between points and the need to meet the conditions of the completion criteria, namely that pasture mass is not significantly different from unmined areas, with adequate sampling to detect ≥10% difference between groups. An appropriate sample size (n) is based on the following formula:

$$n = 15.68*\sigma^2 / d^2,$$

where σ^2 is the population variance, and d is the minimum difference required to be detected. This formula is based on a standard 95% confidence interval and 80% power. It is anticipated that several hundred point-readings are likely to be required per rehabilitation area and reference paddock. Data from the first 100 readings can be used to calculate n for a d value that represents 10% of the mean dry mass at the reference site. Reference and rehabilitation areas are to be assessed concurrently, at the end of the growing season (April-May).

2) **Satellite estimation of pasture growth rate.** The CSIRO is in the process of developing their "Pastures from Space" website, which uses satellite imagery to provide real-time data on pasture growth rates at fine spatial scales. This technique has been optimised for temperate Australian pastures, but its applicability to the tropics and subtropics remains unclear. With further development and optimisation, this tool could provide a highly efficient method for comparing pasture productivity between rehabilitation and reference areas, without the need to undertake labour-intensive field studies. It is expected that this tool may be available by the time pasture productivity monitoring is to commence at the Project (i.e., six years after the first planting).

9.1.7 Rehabilitation Milestone 7: Establishment of Target Vegetation in non-riparian areas

Rehabilitation areas requiring the assessment of target vegetation in non-riparian areas include RA1, RA4, RA6, RA8 and RA10.

Field Surveys

Field surveys are to monitor the following attributes of rehabilitation areas:

- relative dominance of Koala food trees;

- height of Koala food trees;
- basal area of *Casuarina cristata*;
- species richness of Greater Glider food trees;
- percentage cover of declared weeds;
- species composition of the pasture;
- density of woody vegetation within rehabilitated areas is to be sufficient for Squatter Pigeons; and
- availability of food for the Glossy Black-Cockatoo
- bio Condition score in accordance with BioCondition Assessment manual.
- Rehabilitation is to be non-polluting as derived from surface water quality criteria and soil testing.

These attributes are to be measured within a 10 m × 50 m belt transect installed within rehabilitation areas.

Tree height is measured with a range-finder or clinometer. The five tallest Koala trees present within the belt transect are to be measured.

Basal area of woody vegetation is to be measured using a Bitterlich gauge. Each species of tree/shrub is to be measured separately. Each site is to be assessed using two 360° sweeps of the gauge (one at each end of the transect, 50 m apart), and the basal area of each woody species is the average from the two sweeps. The proportion of the total basal area of all woody vegetation that comprises Koala food trees (*Eucalyptus crebra, Eucalyptus populnea* and *Eucalyptus camaldulensis*) is used to assess the milestone criterion pertaining to Koalas. The total basal area of *Casuarina cristata* is used to assess the milestone criterion pertaining to Glossy Black-Cockatoos. The presence of different *Eucalyptus* and *Corymbia* species is used to the milestone criterion pertaining to the Greater Glider.

The entire belt transect is to be searched, and all species of forbs and grasses contained within it are to be recorded. Percentage ground cover of each species is to be estimated to the nearest 0.1%, with 0.1% cover being equivalent to 0.5 m^2 total cover within the transect. From this data, milestone completion criteria pertaining the grass species richness and weed cover can be assessed.

Field surveys are to be undertaken in the late wet season (February-May), to coincide with maximum growth of grasses and forbs. Permanent monitoring sites are to be installed within all rehabilitation areas, and each end of each transect is to be marked with a star picket. An average of one monitoring site is to be installed per 10 ha of rehabilitated land.

Reference sites are to be installed in nearby undisturbed land used for grazing. Reference sites are to be of a similar soil type and slope to rehabilitated sites, and must have a vegetation density appropriate for Squatter Pigeons.

Reference sites will be selected to (a) meet the requirements for soil, slope and vegetation density, (b) be evenly spaced, with at least 500 m between them, and (c) be preferentially located within the MLA area, and therefore not subject to any external access permissions. To avoid biases in the placement of these reference sites, their coordinates will be selected based on GIS information rather than through site visits. The baseline condition of reference sites must represent a random sample of analogous, nearby, unmined vegetation communities.

Reference sites are to be surveyed concurrently with every second rehabilitation area monitoring round. Reference sites must be monitored in the year rehabilitation success is expected. Vegetation development is to be assessed every two years until milestone criteria have been achieved.

After vegetation establishment (after 6 to 12 months since sowing) soils will be re-tested to determine if any follow-up application of ameliorants is required.

BioCondition Assessment

All RE's across the project area must achieve a BioCondition score of at least 40/80, based on benchmarks relevant to an analogous regional ecosystem and site based attributes only. A milestone criteria target

BioCondition score of 40/80, is proposed because studies conducted in similar environments concluded this to be a suitable score. A mean score of 42/80 was achieved by 10-20 year old rehabilitated sites at Meandu, southeast Queensland, the only site for which publicly available data is available (Ngugi & Neldner, 2015), suggesting that 40/80 is a reasonable and achievable target for the Project. The monitoring of BioCondition is to be undertaken by an appropriately qualified person in accordance with the latest version of the BioCondition Assessment Manual.

All RE's within the project area that are classified as 'native ecosystem' will be reinstated to their initial classification. A few examples of the dominant RE's across the project area to be reinstated are summarised below in **Table 9-2** below.

Table 9-2 Summary of dominant RE's across project area

Regional Ecosystems	Description
11.10.3	*Acacia Shirleyi* open forest
11.5.9	*Eucalyptus crebra* and *melanophloia* woodland
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland to open woodland

The methodology to be adopted when undertaking habitat quality assessments with regard to environmental offsets in Queensland is prescribed by the Guide to Determining Terrestrial Habitat Quality version 1.3 (Department of Environment and Science 2020a) (see **Appendix I**). BioCondition will be assessed following the methodology prescribed by the BioCondition Assessment Manual version 2.2 (Eyre et al. 2015). This methodology uses quadrat sampling to generate measurements of native plant richness, recruitment, shrub and tree cover, native perennial grass cover, litter cover, amount of coarse woody debris, nonnative plant cover, tree height and number of large trees. These measurements are then compared to benchmarks published by the Queensland Herbarium compiled from various reference sites. The most recent revision (version 3.2) of these the benchmarks will be used. Each RE will also be assessed against different reference site benchmarks, to account for variability in "quality" between RE's, as per **Table 9-3**.

The scoring system prescribed by the BioCondition Assessment Manual version 2.2 (Department of Science, Information Technology, Innovation and the Arts 2015) results in a score out of 80, while the Guide to determining terrestrial habitat quality version 1.3 (Department of Environment and Science 2020a) requires that this score is out of 100. To achieve this conversion, the original score will be multiplied by 1.25.

Table 9-3 BioCondition benchmark criteria

Table 1. Pre-mining Regional ecosystems references – Native ecosystem

Relevant PMLU	Native Vegetation																	
BioCondition Assessable Attributes	11.4.8			11.5.3			11.9.2			11.10.1			11.10.3			11.5.9		
	40/80	60/80	80/80	40/80	60/80	80/80	40/80	60/80	80/80	40/80	60/80	80/80	40/80	60/80	80/80	40/80	60/80	80/80
Recruitment (tree species)	1	2	3	3	4	6	1	1	2	2	3	4	1	2	3	1	2	3
Non-native plant cover (%)	max. 10	max. 5	0	max. 10	max. 5	0	max. 10	max. 5	0	max. 10	max. 5	0	max. 10	max. 5	0	max. 10	max. 5	0
Tree (native) species richness*	1	2	3	3	4	6	1	1	2	2	3	4	1	2	3	1	2	3
Shrub (native) species richness*	5	7	10	3	4	6	5	7	10	2	3	4	2	3	4	3	4	6
Grass (native) species richness*	4	7	9	3	4	6	3	5	7	4	7	9	3	5	7	4	7	9
Forb/other (native) species richness	3	5	7	5	7	10	6	9	12	8	13	17	4	7	9	5	8	11
Tree canopy cover (%)	8	13	17	8	12	16	7	11	15	12	18	24	7	11	15	12	19	25
Native perennial grass cover (%)	10	15	20	9	14	19	9	13	18	8	12	16	11	17	23	13	19	26
Litter and other vegetation cover (%)	18	28	37	10	15	20	15	22	30	25	37	50	16	24	32	15	22	30

*Species richness must be based on species that occur in the RE technical description (refer Attachment 2).

9.1.8 Rehabilitation Milestone 8: Establishment of Target Vegetation in riparian areas

All information described above in **Section 9.1.7** applies for RM8 and this milestone criteria will be managed in the same way. Rehabilitation areas requiring the assessment of target vegetation establishing in riparian areas include RA3.

Additional criteria unique to this milestone are described below.

Field Surveys

Field surveys are to monitor the following attributes of rehabilitation areas:

- percentage basal area of *Eucalyptus camaldulensis*;
- BioCondition score relevant to the analogous regional ecosystem 11.3.25; and
- soil testing for rootzone EC, Soil pH and Exchangeable Sodium Percentage (ESP).

These attributes are to be measured within a 10 m × 50 m belt transect installed within rehabilitation areas.

Eucalyptus camaldulensis is to constitute 33% of the total basal area of woody vegetation as measured using a Bitterlich (described in **Section 9.1.7** above). Rehabilitation areas must achieve a BioCondition score of at least 40/80, based on benchmarks relevant to the analogous regional ecosystem 11.3.25 using site-based attributes only. The methodology for BioCondition assessments is described above in **Section 9.1.7.**

Soil testing will be conducted on the following parameters:

- Rootzone EC <1.5 dS/m (1,500 µS/cm);
- Soil pH <8.5 and >6 as measured at any part of the root zone; and
- Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).

9.1.9 Rehabilitation Milestone 9: Achievement of native ecosystem land use with a stable condition

The achievement of a stable landscape that can support ecosystem land use is to be monitored through field survey programs, described below. Rehabilitation areas related to the achievement of the native ecosystems PMLU include RA3, RA4, RA6, RA8 and RA10.

Presence of species

Field surveys (measured within a 10 m × 50 m belt transect installed within rehabilitation areas) are to assess the following rehabilitation criteria have occurred to determine milestone success:

- at least 50% of established species show natural recruitment and therefore soil amelioration techniques and seed mixes are appropriate for rehabilitation goals;
- *Eucalyptus crebra*, *Eucalyptus orgadolphila* and/or *Eucalyptus populnea* are to constitute 21% of the total basal area of woody vegetation on soil management units Limpopo, Fish, Kei and Komati;
- rehabilitated areas are to contain *Eucalyptus camaldulensis* and at least one other species of Corymbia or Eucalyptus;
- rehabilitated areas where the ground is level and soil management unit "Orange" has been used as topsoil are to have a minimum stem basal area of 0.5m2/ha of *Casuarina cristata*; and
- sites fulfil all other milestone criteria after having experienced at least one “drought” year (defined as having a total rainfall over a 12-month period that falls within the lowest decile recorded at the nearest weather station, Moranbah Airport). This is to ensure the longevity of rehabilitation and its sustainability into the future across diverse climactic and environmental conditions.

Landscape Function Analysis

Monitoring of the stability of rehabilitated land is to be based on the “stability index” of Landscape Function Analysis (LFA) (Tongway and Hindley 2004). Methodology to be adopted is described in detail by Tongway and Hindley (2004). Permanent monitoring sites used for vegetation monitoring are also to be monitored for soil stability.

Monitoring is to take place in the late wet season (February-May), to coincide with maximum plant growth. Reference sites are to be monitored at the time of planting and then every two years for ten years after planting. This time series of six intervals will generate a sigmoidal curve for the stability index. A stable PMLU will be achieved when the landscape function analysis scores for soil stability have started to plateau, and the plateau values predicted from sigmoidal curve fitted to the data are equivalent to or exceed values at analogue sites (Tongway and Hindley 2004). If the curve does not plateau or exceed the target value within ten years, additional rounds of monitoring will take place every five years until the target is achieved.

Slope gradients, soil types and vegetation densities have all been considered when site locations were chosen. The Locations of proposed reference sites are listed in **Table 9-4.**

Table 9-4 Proposed reference sites for LFA monitoring

Site	Slope	Start Easting	Start Northing	End Easting	End Northing
R1	Flat[2]	620964.65097	7535047.20624	620992.47603	7535085.49969
R2	Flat	620844.94853	7534066.38659	620894.26898	7534058.12426
R3	Flat	629184.84267	7522788.01160	629230.03485	7522797.59895
R4	Flat	627353.36337	7525088.33690	627389.73435	7525118.17137
R5	Flat	624851.64841	7527710.07831	624902.85635	7527702.30345
R6	Sloping[3]	619917.42716	7535876.11707	619930.41274	7535827.41415
R7	Sloping	620078.22373	7535360.09998	620111.95529	7535367.34973
R8	Sloping	620303.14802	7534902.02272	620313.05410	7534948.37178
R9	Sloping	623912.93586	7524955.12550	623958.71296	7524958.20992
R10	Sloping	626001.58270	7523995.80409	625981.64716	7523952.12251

Reference sites are to be surveyed concurrently with every second round of rehabilitation area monitoring. Reference sites must be monitored in the year rehabilitation success is expected. Vegetation development is to be assessed every two years until milestone criteria have been achieved.

BioCondition Assessment

All RE's across the project area must achieve a BioCondition score of at least 60/80 for achievement of native ecosystem land use with a stable condition, based on benchmarks relevant to an analogous regional ecosystem and site based attributes only. The monitoring of BioCondition is to be undertaken by an appropriately qualified person as per the latest version of the BioCondition Assessment Manual.

All RE's within the project area that are classified as 'native ecosystem' will be reinstated to their initial classification. A few examples of the dominant RE's across the project area to be reinstated are summarised in **Table 9-2.**

The methodology to be adopted when undertaking habitat quality assessments with regard to environmental offsets in Queensland is prescribed by the Guide to Determining Terrestrial Habitat Quality version 1.3 (Department of Environment and Science 2020a). BioCondition will be assessed following the methodology prescribed by the BioCondition Assessment Manual version 2.2 (Eyre et al. 2015). This methodology uses quadrat sampling to generate measurements of native plant richness, recruitment, shrub and tree cover, native perennial grass cover, litter cover, amount of coarse woody debris, nonnative plant cover, tree height and number of large trees. These measurements are then compared to benchmarks published by the Queensland Herbarium compiled from various reference sites. The most recent revision (version 3.2) of these the benchmarks will be used. Each RE will also be assessed against different reference site benchmarks, to account for variability in "quality" between REs.

The scoring system prescribed by the BioCondition Assessment Manual version 2.2 (Department of Science, Information Technology, Innovation and the Arts 2015) results in a score out of 80, while the Guide to determining terrestrial habitat quality version 1.3 (Department of Environment and Science 2020a) requires that this score is out of 100. To achieve this conversion, the original score will be multiplied by 1.25.

Ground Cover

Landscape Function Analysis, discussed above, involves an assessment of percentage ground cover as classes.

[2] Flat- reference sites located on slope gradients less than 6%.
[3] Sloping- reference sites located on slope gradients between 10-20%.

A more accurate measurement is required to specifically assess the rehabilitation completion criteria that "Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower then 10%". While this criteria relates specifically to rehabilitation areas to which cattle have been introduced (at advanced stages of rehabilitation development), it is prudent to commence this monitoring prior to the introduction of cattle. This data can then be used to calculate the effect of grazing on percentage cover, and thereby predict the groundcover expected at ungrazed sites following cattle introduction. This in turn will be useful for adjusting stocking rates, if required.

Ground cover is to be calculated by running a 50 m measuring tape along the length of each vegetation monitoring transect. Observations of the type of cover (limited to the cover present below 1 m above ground level) are made at point intercepts along the centre line of the 50 m transect at 0.5 m intervals. Cover types include (a) vegetation (including all live vegetation and standing senescent vegetation that is still attached to the main plant and is not in intimate contact with the soil); (b) leaf litter and woody debris; (c) rock or (d) bare ground. The cover type that is intercepted directly below each point is recorded. The intercept point is to be assessed by viewing the ground through a small observation hole (in a piece of stiff card or plastic) or tube. Preferably, this should contain a cross hair, although this is not obligatory. A total of 100 observations are made per transect, and the sum of each cover type equates to its percentage cover.

Percentage cover is to be assessed at rehabilitation sites only (reference site data is not required). Monitoring is to be undertaken concurrently with assessments of landscape function and vegetation surveys in the late wet season.

Erosion Monitoring

Additional erosion monitoring across the landform will also be undertaken for the early detection of erosion, to allow for early intervention.

In-field erosion monitoring will be undertaken at permanent monitoring transects, (50 m in length) established across the landform in conjunction with the LFA monitoring sites, to provide a basis for temporal assessments.

Visual observations will be taken whilst traversing transects on foot and recording the number and average depth of any erosion features, rill lines or gullies. Visual assessments should identify any evidence of excessive sediment movement, including the formation of rills, removal of soil around the base of plants and accumulation of loose sediment at the base of slopes. In-field erosion monitoring will be accompanied by assessment of the water quality of run-off water released from the catchment of given rehabilitation areas. There must be no evidence of erosion classified as 'moderate' or 'severe' as defined by classification framework in **Table 9-1.**

Erosion monitoring methodology is further detailed in Section 9.6 of the **Vulcan South Soils and Land Suitability Assessment** (**Appendix C**).

Water Quality

The Project will have a groundwater and surface water monitoring program operating throughout all phases of the Project, including through rehabilitation and closure. The proposed surface water monitoring and groundwater locations that will be used to assess this milestone are shown in **Figure 9-2** and **Table 9-5,** and **Figure 9-3** and **Table 9-6**, respectively. Surface water and groundwater quality objectives as per the approved EA100265081 are provided in **Table 9-7** and **Table 9-8**, respectively.

For a detailed description of the methodology to be adopted and the location of sampling sites, refer to the Receiving Environment Water Monitoring Program, which is to be completed prior to the commencement of the Project. A surface water monitoring schedule and proposed monitoring locations are presented in **Appendix A**. A Groundwater Impact Assessment has been developed with proposed monitoring locations presented in **Appendix B.**

Table 9-5 Provisional Surface Water monitoring locations

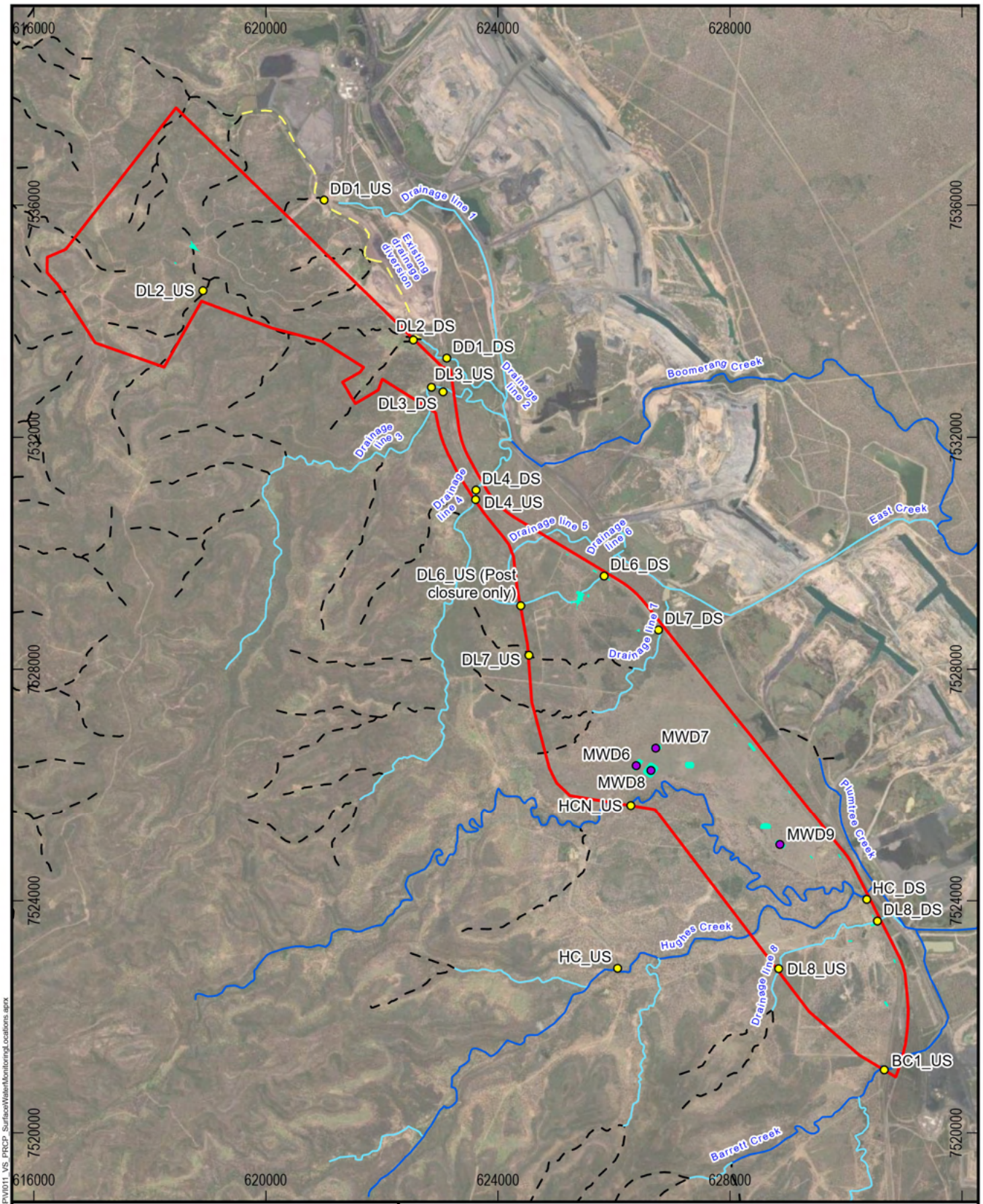
Station ID	Previous station ID	Catchment area	Easting*	Northing*	Description
Upstream sites					
DL2_US	N/A	Boomerang Creek	618,915	7,534,526	Drainage line 2 upstream of the highwall mining area
DL3_US	N/A	Boomerang Creek	622,854	7,532,860	Drainage line 3 upstream of the haul road
DL4_US	N/A	Boomerang Creek	623,615	7,530,925	Drainage line 4 at the upstream mining lease boundary
DL6_US (Post-closure only)	N/A	East Creek	624,394	7,529,095	Drainage line 6 at the upstream mining lease boundary
DL7_US	N/A	East Creek	624,535	7,528,242	Drainage line 7 at the upstream mining lease boundary
HCN_US	N/A	Hughes Creek	626,291	7,525,650	Hughes Creek north tributary approximately 5.5 km upstream of Saraji Road
HC_US	VSW5	Hughes Creek	626,063	7,522,835	Hughes Creek approximately 2.8 km upstream of Saraji Road
DL8_US	N/A	Hughes Creek	628,840	7,522,828	Drainage line 8 approximately 2.2 km upstream of Saraji Road
BC1_US	VSW6	Hughes Creek	630,660	7,521,085	Barrett Creek upstream of Saraji
Downstream sites					
DD1_US	VSW1	Boomerang Creek	621,004	7,536,087	Diversion bund approximately
DD1_DS	VSW2	Boomerang Creek	623,118	7,533,363	Drainage line 2, downstream of the confluence of existing diversion drain
DL2_DS	VSW11	Boomerang Creek	622,542	7,533,676	Drainage line 2 upstream of confluence of existing diversion drain
DL3_DS	VSW3	Hughes Creek	623,054	7,532,781	Minor drainage line, upstream of confluence of Drainage Line 2
DL4_DS	VESW4	Hughes Creek	623,622	7,531,089	Drainage line 4 upstream of the confluence of Boomerang Creek
DL6_DS	VSW9	East Creek	625,831	7,529,607	Drainage line 6, at the downstream mining lease boundary
DL7_DS1	VSW7	East Creek	626,768	7,528,678	Drainage line 7, at the downstream mining lease boundary
HC_DS1	VSW4	Hughes Creek	630,358	7,524,022	Hughes Creek at the downstream mining lease boundary
DL8_DS	VSW10	Hughes Creek	630,542	7,523,649	Drainage line 8 at the downstream mining lease boundary
Mine Water Dams					
MWD6	N/A	MWD Monitoring point	626,384	7,526,339	MWD6 spillway
MWD7	N/A	MWD Monitoring Point	626,720	7,526,641	MWD7 spillway
MWD8	N/A	MWD Monitoring Point	626,638	7,526,257	MWD8 spillway
MWD9	N/A	MWD Monitoring Point	628,861	7,524,969	MWD9 spillway

*GDA2020 MGAz55

Table 9-6 Provisional Groundwater monitoringlocations

Groundwater bore	Latitude	Longitude
MB01	22.333428732° S	22.333428732° S
MB01R	148.220070636° E	148.220070636° E
MB06	22.333428732° S	22.333428732° S
MB07	148.220070636° E	148.220070636° E
MB08	22.360790237° S	22.360790237° S
MB09	148.247150363° E	148.247150363° E
MB10	22.364540522° S	22.364540522° S
MB11	148.250437058° E	148.250437058° E
MB12	22.357739524° S	22.357739524° S
MB12R	148.244501266° E	148.244501266° E
MB14	22.373728533° S	22.373728533° S
MB15	148.258356674° E	148.258356674° E
MB16	22.360862044° S	22.360862044° S
MB17	148.247209269° E	148.247209269° E
MB18	**22.350287991° S**	**22.350287991° S**

*GDA2020 MGAz55



Legend

- MLA Boundary
- Dams
- Proposed Surface Water Monitoring Locations
  - Receiving water monitoring site
  - Mine water dam monitoring location
- Local Drainage Features
  - Minor Drainage Features
  - Drainage Features
  - Drainage Diversion
  - Watercourse

Source: WRM 2023, State of Queensland (Department of Resources) 2021-2023, Vitrinite 2023, METServe 2023, Earthstar Geographics.

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_SurfaceWaterMonitoringLocations.aprx

Vulcan South

Surface Water Monitoring Locations

0 1 2 3

Kilometers

Scale: 1:95,000 (A4)

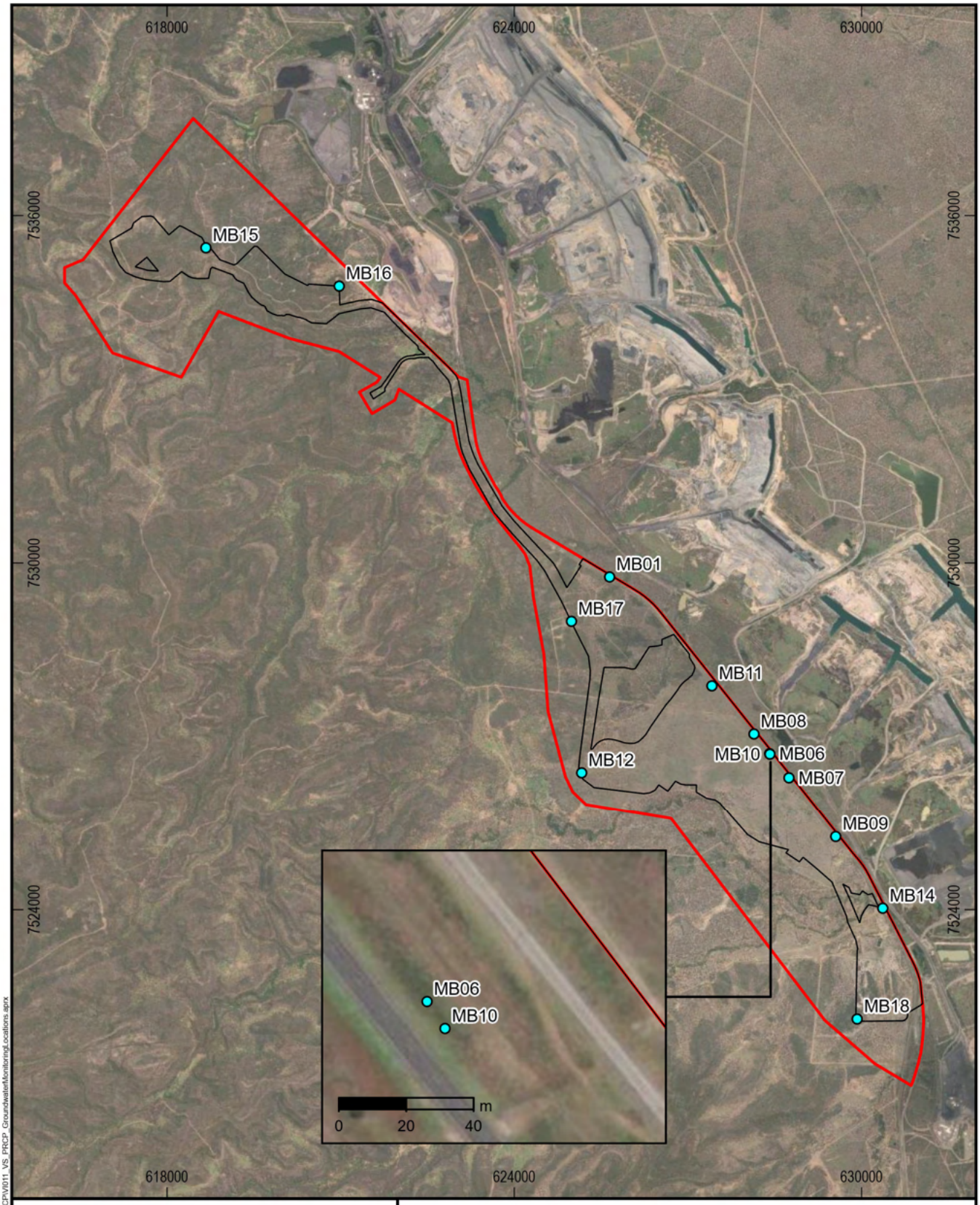
2/01/2024

Datum: GDA2020
Projection: MGA55

FIGURE 9-2

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd



Legend

- Groundwater Monitoring Bores
- Vulcan South Maximum Disturbance Footprint
- MLA Boundary

Source: Geoscience Australia 2020, hydrogeologist.com.au 2023, Vitrinite 2022, METServe 2023, Earthstar Geographics, Maxar, Esri, and the GIS User Community.

Vulcan South

Groundwater Monitoring Locations

0 1 2 3

Kilometers

Scale: 1:95,000 (A4)

7/12/2023

Datum: GDA2020
Projection: MGA55

FIGURE 9-3

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_GroundwaterMonitoringLocations.aprx

Table 9-7 Surface Water Quality Objective as per approved Vulcan South EA100265081

Quality Characteristic (units)	Sediment dam trigger value	Downstream monitoring point trigger value	Source	Frequency
pH	6.5-8.5	6.5-8.5	EPP WQO (aquatic ecosystems)	Monthly and Daily during release (the first sample must be taken within 2 hours of commencement of release
Electrical conductivity (µS/cm)	864*	Baseflow: 720 Medium flow: 500 High flow: 250	EPP WQO	
Turbidity (NTU)	60*	50	EPP WQO	
Total Suspended Solids (mg/L)	102^	85	EPP WQO	
Sulphate as SO4 (mg/L)	37#	25	EPP WQO	
Ammonia (µg/L)	900	900	ANZG 2018	
Nitrate (µg/L)	1100	1100	For aquatic ecosystem protection, based on ambient Qld WQ Guidelines (2006) for Total Nitrate	
Filtered metals and metalloids				
Aluminium (µg/L)	192*	160	Locally derived	Monthly and Commencement of release and thereafter weekly during release
Arsenic (µg/L)	16*	13	ANZG 2018	
Lead (µg/L)	4.1*	3.4	ANZG 2018	
Mercury (µg/L)	0.72	0.6	EPP WQO (aquatic ecosystems)	
Molybdenum (µg/L)	40.8*	34	EPP WQO (aquatic ecosystems)	
Selenium (µg/L)	**6***	**5**	**ANZG2018**	

All metals and metalloids must be measured as 'dissolved' (from analysis of a field filtered sample) and total (unfiltered). Limits for metals and metalloids apply to dissolved results.

*20% increase on trigger value

95th percentile site specific

^locally derived trigger values (80th percentile values of natural surface water monitoring)

Table 9-8 Groundwater Quality Objectives as per approved Vulcan South EA100265081 (Table E2)

Parameter	Unit	Bores	Limit	Comment
pH (field)	pH unit	All bores	5.5-8.0	ANZG (2018)
*** Electrical Conductivity (Field)**	(µS/cm)	MB01R^	16,000*	EPP WQO
		MB07	5,791	Site-specific 95th percentile
		MB09	12,007	Site-specific 95th percentile
		MB10	4,102	Site-specific 95th percentile
		MB12	22,872	Site-specific 95th percentile
		MB12R^	16,000*	EPP WQO
		MB14	16,000*	EPP WQO
		MB15	16,000*	EPP WQO
		MB16	16,000*	EPP WQO
		MB17	16,000*	EPP WQO
		MB18	16,000*	EPP WQO
***Sulphate**	Mg/L	MB01R^	398*	EPP WQO
		MB07	707	Site-specific 95th percentile
		MB09	769	Site-specific 95th percentile
		MB10	418	Site-specific 95th percentile
		MB12	874	Site-specific 95th percentile
		MB12R^	398*	EPP WQO
		MB14	398*	EPP WQO
		MB15	398*	EPP WQO
		MB16	398*	EPP WQO
		MB17	398*	EPP WQO
		MB18	398*	EPP WQO
Dissolved Metals and metalloids				
Aluminium	mg/L	All bores	0.055	ANZG (2018)
Arsenic	mg/L	All bores	0.013	ANZG (2018)
Barium	mg/L	All bores	0.10	Site-specific 95th percentile (grouped)
Boron	mg/L	All bores	0.66	Site-specific 95th percentile (grouped)

Cobalt	mg/L	All bores	0.004	Site-specific 95th percentile (grouped)
Copper	mg/L	All bores	0.0014	ANZG (2018)
Iron	mg/L	MB01R^	0.246*	EPP WQO
		MB07	0.46	Site-specific 95th percentile
		MB09	0.38	Site-specific 95th percentile
		MB10	0.2	Site-specific 95th percentile
		MB12	4.94#	Site-specific 95th percentile
		MB12R^	0.246*	EPP WQO
		MB14	0.246*	EPP WQO
Lead	mg/L	All bores	0.0034	ANZG (2018)
Mercury	mg/L	All bores	0.0006	ANZG (2018)
Molybdenum	mg/L	All bores	0.034	ANZG (2018)
Selenium	mg/L	All bores	0.005	ANZG (2018)
Strontium	mg/L	MB01R^	TBD	Site-specific 95th percentile
		MB07	2.2	Site-specific 95th percentile
		MB09	5.7	Site-specific 95th percentile
		MB10	1.2	Site-specific 95th percentile
		MB12	8.4	Site-specific 95th percentile
		MB12R^	TBD*	Site-specific 95th percentile
		MB14	TBD*	Site-specific 95th percentile
		MB15	TBD*	Site-specific 95th percentile
		MB16	TBD*	Site-specific 95th percentile
		MB17	TBD*	Site-specific 95th percentile
		MB18	TBD*	Site-specific 95th percentile
Uranium	mg/L	MB01R^	0.0005*	ANZG 2018
		MB07	0.003	Site-specific 95th percentile

		MB09	0.005	Site-specific 95th percentile
		MB10	0.0005*	ANZG 2018
		MB12	0.0005*	ANZG 2018
		MB12R^	0.0005*	ANZG 2018
		MB14	0.0005*	ANZG 2018
		MB15	0.0005*	ANZG 2018
		MB16	0.0005*	ANZG 2018
		MB17	0.0005*	ANZG 2018
		MB18	0.0005*	ANZG 2018
TRH (C6-C10)	µg/L	All bores	<20	LOR
TRH (C10-40)	µg/L	All bores	<50	LOR
Major Ions				
Major ions (mg/L) (calcium, chloride, potassium, magnesium, sodium, bicarbonate, carbonate)	mg/L	All bores	For interpretation purposes only	
Hardness	**Mg/L**	**All bores**	**For interpretation purposes only**	

Notes:

All metals and metalloids must be measured as 'dissolved' (from analysis of a field filtered sample) and total (unfiltered). Limits are based on 'dissolved' measurements.

* Site-specific limits are to be provided in accordance with condition E11.

^ indicates replacement bores to be installed to replace dry bores and bores that require relocation due to mining activities.

Requires additional investigated to ensure it is indicative of background conditions.

EPP WQO: Groundwater quality parameters derived from EPP (water) policy 2009 Isaac River Sub-basin Environmental Values and Water Quality Objectives Basin No. 130 (part), including all waters of the Isaac River Sub-basin (including Connors River), Zone 34-deep (80th percentile).

Receiving Environment Monitoring Program

A receiving environment monitoring program (REMP) document, describing in detail the proposed monitoring program for the local receiving waters, will be designed and implemented. The REMP will incorporate the current, historical and proposed monitoring as described in **Appendix A**.

Downstream monitoring points will be used to assess the water quality of the receiving waters in the context of rehabilitation establishment prior to removal of sediment dams and ultimately cessation of water monitoring. In addition to routine monitoring, these sites will be monitored directly after release events to assess the effect of releases.

Release contaminant trigger investigation levels

A set of initial proposed receiving water contaminant triggers levels have been developed, based on conditions at nearby operating coal mines, preliminary baseline results and the water quality objectives for the vicinity of the Project. These trigger levels are presented in **Appendix A** and are proposed to be measured against at the downstream water monitoring locations. Monitoring at these locations will allow for an accurate evaluation of the impact of any releases from the Project.

Drawdown monitoring

Ongoing monitoring of groundwater levels in the monitoring bore network will enable natural groundwater level fluctuations (such as responses to rainfall recharge) to be distinguished from potential groundwater level impacts (drawdown) due to dewatering/depressurisation resulting from proposed mining activities. Automatic data loggers are currently installed in the groundwater monitoring network, and they record daily measurements. These data loggers will be downloaded quarterly to coincide with groundwater quality sampling.

Drawdown due to the proposed Project is predicted to be limited to generally less than 2 km from the proposed pits (that is the lateral distance from the pit to the 1 m drawdown contour). This limited drawdown propagation is mainly due to the limited saturation of aquifers in the Project area, low hydraulic conductivities and low storage coefficients. The predicted drawdown extends east, toward Saraji Mine.

The groundwater monitoring network established by hydrogeologist.com.au (2022) will form the basis for ongoing drawdown monitoring and management through the life of the Project.

Areas not relevant for this milestone

In the event parts of the proposed disturbance footprint are not actually disturbed, undisturbed portions of "rehabilitation areas" will not be subject to the same set of milestone criteria as the disturbed portions. For example, the highwall mining area plunges are not expected to create surface disturbance, however; this area has still been considered within the disturbance footprint.

9.1.10 Rehabilitation Milestone 10: Achievement of cattle grazing land use with stable condition

The achievement of a stable landscape that can support 'low-intensity cattle grazing' is to be monitored through field survey programs, described below. Rehabilitation areas pertaining to this include RA2, RA5, RA7 and RA9.

Landscape Function Analysis

This is to be monitored as is described in **Section 9.1.9**

Ground Cover

Landscape Function Analysis, discussed above, involves an assessment of percentage ground cover as classes.

A more accurate measurement is required to specifically assess the rehabilitation completion criteria that "Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower then 10%". While this criteria relates specifically to rehabilitation areas to which cattle have been introduced (at advanced stages of rehabilitation development), it is prudent to commence this monitoring prior to the introduction of cattle. This data can then be used to calculate the effect of grazing on percentage cover, and thereby predict the groundcover expected at ungrazed sites following cattle introduction. This in turn will be useful for adjusting stocking rates, if required.

Ground cover is to be calculated by running a 50 m measuring tape along the length of each vegetation monitoring transect. Observations of the type of cover (limited to the cover present below 1 m above ground level) are made at point intercepts along the centre line of the 50 m transect at 0.5 m intervals. Cover types include (a) vegetation (including all live vegetation and standing senescent vegetation that is still attached to the main plant and is not in intimate contact with the soil); (b) leaf litter and woody debris; (c) rock or (d) bare ground. The cover type that is intercepted directly below each point is recorded. The intercept point is to be assessed by viewing the ground through a small observation hole (in a piece of stiff card or plastic) or tube. Preferably, this should contain a cross hair, although this is not obligatory. A total of 100 observations are made per transect, and the sum of each cover type equates to its percentage cover.

Percentage cover is to be assessed at rehabilitation sites only (reference site data is not required). Monitoring is to be undertaken concurrently with assessments of landscape function and vegetation surveys in the late wet season.

Erosion Monitoring

Additional erosion monitoring across the landform will also be undertaken for the early detection of erosion (as per milestone 3, 4 and 6), to allow for early intervention. All corrective actions recommended by an AQP in response to erosion or deficient vegetation cover will have been implemented prior to the achievement of a final PMLU.

In-field erosion monitoring will be undertaken at permanent monitoring transects, (50 m in length) established across the landform in conjunction with the LFA monitoring sites, to provide a basis for temporal assessments.

Visual observations will be taken whilst traversing transects on foot and recording the number and average depth of any erosion features, rill lines or gullies. Visual assessments should identify any evidence of excessive sediment movement, including the formation of rills, removal of soil around the base of plants and accumulation of loose sediment at the base of slopes. In-field erosion monitoring will be accompanied by assessment of the water quality of run-off water released from the catchment of given rehabilitation areas.

Erosion monitoring methodology is further detailed in Section 9.6 of the **Vulcan South Soils and Land Suitability Assessment** (**Appendix C**). There must be no evidence of erosion classified as 'moderate' or 'severe' as defined by classification framework in **Table 9-1.**

For the PLMU of cattle grazing, pasture productivity within rehabilitated sites is to be equivalent to nearby unmined sites on the same soil types. Pasture productivity is to be assessed via one of two methods:

1) **Manual measurements of pasture mass at specific moments in time.** An electronic dry matter capacitance meter (e.g., Grassmaster Pro) can be used to estimate pasture dry mass (kg/ha) at points within rehabilitation areas. This technique is superior to traditional plate meters on stony ground, such as will be found on sloping rehabilitation areas. The exact number of replicate points required per rehabilitation area is dictated by the variation observed between points and the need to meet the conditions of the completion criteria, namely that pasture mass is not significantly different from unmined areas, with adequate sampling to detect ≥10% difference between groups. An appropriate sample size (n) is based on the following formula:

$$n = 15.68*\sigma^2 / d^2,$$

where σ^2 is the population variance, and d is the minimum difference required to be detected. This formula is based on a standard 95% confidence interval and 80% power. It is anticipated that several hundred point-readings are likely to be required per rehabilitation area and reference paddock. Data from the first 100 readings can be used to calculate n for a d value that represents 10% of the mean dry mass at the reference site. Reference and rehabilitation areas are to be assessed concurrently, at the end of the growing season (April-May).

2) **Satellite estimation of pasture growth rate.** The CSIRO is in the process of developing their "Pastures from Space" website, which uses satellite imagery to provide real-time data on pasture growth rates at fine spatial scales. This technique has been optimised for temperate Australian pastures, but its applicability to the tropics and subtropics remains unclear. With further development and optimisation, this tool could provide a highly efficient method for comparing pasture productivity between rehabilitation and reference areas, without the need to undertake labour-intensive field studies. It is expected that this tool may be available by the time pasture productivity monitoring is to commence at the Project (i.e., six years after the first planting).

Water Quality

This is to be assessed as described in **Section 9.1.9**

Receiving Environment Monitoring Program

As described in **Section 9.1.9**.

Release contaminant trigger investigation levels

As described in **Section 9.1.9**.

Drawdown monitoring

As described in **Section 9.1.9**.

9.1.11 Rehabilitation Milestone 11: Acceptance of Saraji Road by Isaac Regional Council

Vitrinite is signatory to a formal compensation agreement with IRC for the realignment of Saraji Road. This agreement prescribes the terms and conditions for IRC's acceptance of responsibility for the management and maintenance of the realigned road.

Upon completion of the construction of the road realignment, Vitrinite is to provide IRC with a Certificate of Practical Completion. The receipt of this certificate denotes the start of a "Defects Period", during which Vitrinite will continue to be responsible for all maintenance costs associated with rectifying any identified defects in the realignment and must do so at the direction of IRC if required.

The Defects Period will end on the later of a 12-month period after Vitrinite provides IRC with a Certificate of Practical Completion or the date that IRC notifies Vitrinite that the new road alignment is accepted "off maintenance". Rehabilitation milestone 9 is considered complete following this acceptance by IRC.

Inspections of road condition will be the responsibility of IRC, but Vitrinite will be responsible for undertaking traffic monitoring in accordance with the compensation agreement.

9.1.12 Monitoring Report

Rehabilitation milestones RM6, RM7, RM8, RM9 and RM10 are expected to be assessed concurrently and, as they constitute the primary rehabilitation completion criteria for the Project, they will be monitored over an extended period of at least 10 years.

The results of each-yearly monitoring event will be presented in a report that assesses progress of these five milestones. Each report will contain details about how the methodology used is consistent with this PRC Plan. Each report will also discuss how the results obtained indicate progression towards the fulfilment of milestone criteria.

This monitoring report is to be completed by 1 October in the calendar year in which surveys are undertaken, to allow adequate time to report on the findings by the state-wide reporting deadline of 10 December.

9.2 Audits

In accordance with section 285 of the *Environmental Protection Act 1994*, holders of a PRC Plan schedule must commission a rehabilitation auditor to undertake an audit of the PRC Plan schedule every three years. The first audit must be for the three-year period that commences from the day the schedule takes effect. Each subsequent audit period is for the three years commencing on the day after the previous audit period ended. Each audit report must be delivered to the administering authority within four months after the end of each audit period.

In accordance with section 286 of the *Environment Protection Act 1994*, each audit must include the following:

- a statement about whether the holder has complied with the schedule during the audit period;
- a description of actions the holder has taken with respect to rehabilitation milestones and management milestones;
- whether the holder has complied with conditions imposed on the schedule;
- a declaration stating the holder has not knowingly given false or misleading information;
- an assessment of whether the post-mining land use is likely to be achieved; and

- recommendations about actions the holder should take to ensure rehabilitation milestones and management milestones are achieved.

In addition to the mandatory three-yearly audits, the administering authority has the power (under section 322 of the *Environmental Protection Act 1994*) to issue an audit notice, which requires the holder of a PRC Plan schedule to commission an audit.

9.3 Annual Return

In addition to the annual return requirements that relate to EAs in accordance with section 316IA of the *Environmental Protection Act 1994*, the annual return must also include an evaluation of the effectiveness of the PRC Plan schedule, including the environmental management carried out under the schedule, for the year to which the annual return relates. This evaluation must include:

- whether any milestones to be completed under the PRC Plan schedule during the year have been met; and
- whether the conditions imposed on the PRC Plan schedule have been complied with.

9.4 Progressive Rehabilitation Report

In the event that a particular area within the tenure of the Project has been rehabilitated in accordance with all relevant requirements of the *Environmental Protection Act 1994*, the relevant environmental authority, the PRC Plan schedule and any relevant guidelines made under the *Environmental Protection Act 1994*, the holder of the EA can apply for progressive certification. In accordance with section 318ZD of the *Environmental Protection Act 1994*, the application for progressive certification must be accompanied by a progressive rehabilitation report. The requirements for a progressive rehabilitation report are listed in section 318ZF of the *Environmental Protection Act 1994.*

9.5 Final Rehabilitation Report

A final rehabilitation report is to be prepared when applying to surrender the EA. The purpose of this final rehabilitation report is to demonstrate that the conditions of the EA have been complied with, and that rehabilitation of disturbed land has been carried out satisfactorily. The requirements of this final rehabilitation report are listed in section 262 of the *Environmental Protection Act 1994.*

9.6 Post-mining Management Report

A post-mining management report is to be submitted as part of the surrender application for the EA. This report states the requirements for ongoing management of the land and includes an environmental risk assessment. The requirements of this post-mining management report are listed in section 264A of the *Environmental Protection Act 1994.*

10 PRC Plan SCHEDULE

This section has been prepared in accordance with section 126D(1) of the *Environmental Protection Act 1994*. It contains a description of each rehabilitation area, a schedule of land availability for rehabilitation and a detailed description of the rehabilitation milestones that apply to each rehabilitation area. This information is used to develop a PRC Plan schedule that describes when each rehabilitation milestone is to be progressively achieved in each rehabilitation area.

10.1 Final Site Design

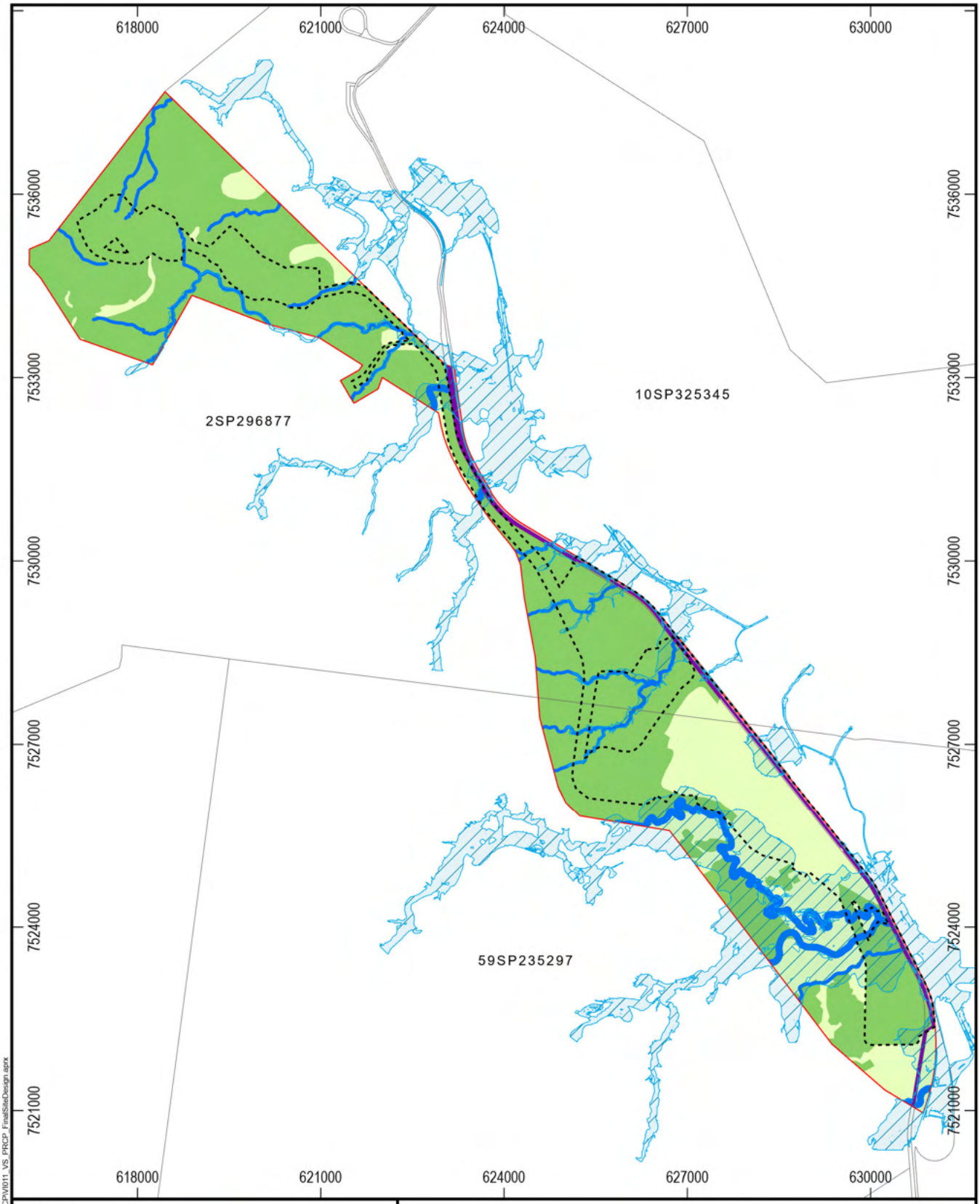
The final site design showing the maximum disturbance footprint, the mining lease boundaries, the PMLU for land within the mining lease, rehabilitation areas and flood plain extent is shown in **Figure 10-1**.

10.1.1 Rehabilitation Areas

The proposed disturbance footprint of the Project has been divided into the following five rehabilitation areas with a common PMLU and rehabilitation methodology:

- RA1: North and South Ex-Pit Waste Rock Dump;
- RA2: Main Ex-pit Waste Rock Dump;
- RA3: Reinstated Watercourses;
- RA4: North and South In-pit Dumps;
- RA5: Main In-pit Waste Rock Dump;
- RA6: Previously wooded infrastructure areas (infrastructure, haul roads, offices, stockpiles, train load-out, rail loop CHPP, MIA and magazine);
- RA7: Previously cleared infrastructure areas (haul roads);
- RA8: Water management infrastructure in previously wooded areas;
- RA9: Water management infrastructure in previously cleared areas;
- RA10: Highwall Mining Area (bench, dams, ex-pit WRD).

The division of the disturbance footprint into rehabilitation areas is shown in **Figure 10-2** and **Figure 10-3**.



Legend

- Cadastral Boundary
- MLA Area
- Vulcan South Maximum Disturbance
- Flood Plain Extent
- Post Mining Land Use (PMLU)
- Grazing
- Native Ecosystems Non-Riparian
- Native Ecosystems Riparian
- Saraji Road
- Rail

Source: State of Queensland (Department of Resources) 2022, Vitrinite 2020-2022, METServe 2020-2023.

Vulcan South

Final Site Design

0 1 2 3

Kilometers

Scale: 1:90,000 (A4)

8/11/2023

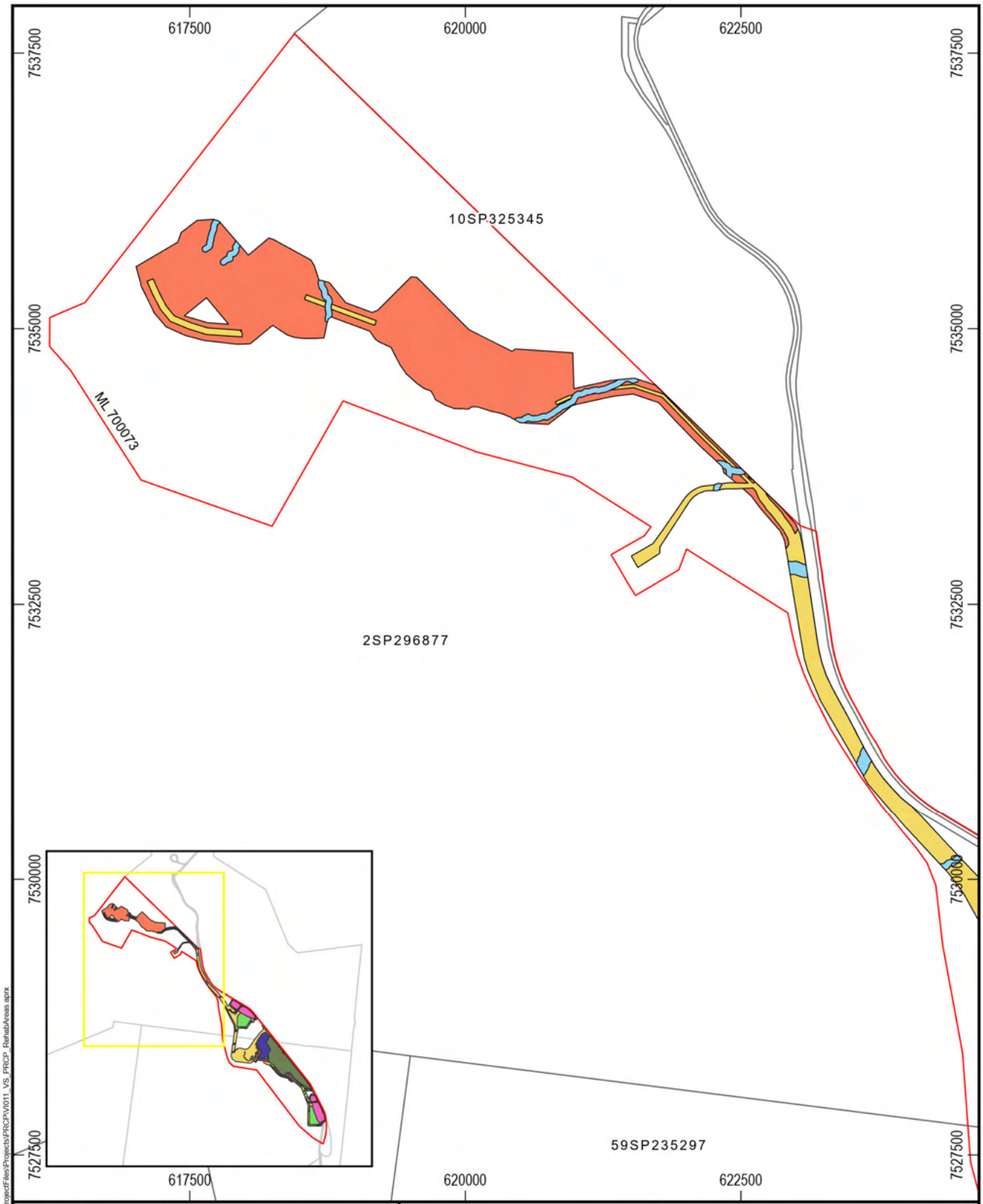
Datum: GDA2020
Projection: MGA55

FIGURE 10-1

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: S:\Projects\V6011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\V6011_VS_PRCP_FinalSiteDesign.aprx



Legend

- Cadastral Boundary
- MLA Area

Rehabilitation Areas

- RA1
- RA2
- RA3
- RA4
- RA5
- RA6
- RA7
- RA8
- RA9
- RA10

Source: State of Queensland (Department of Resources) 2022, Vitrinite 2020-2023, METServe 2020-2023.

Vulcan South

Rehabilitation Areas Northern Section

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

21/11/2023

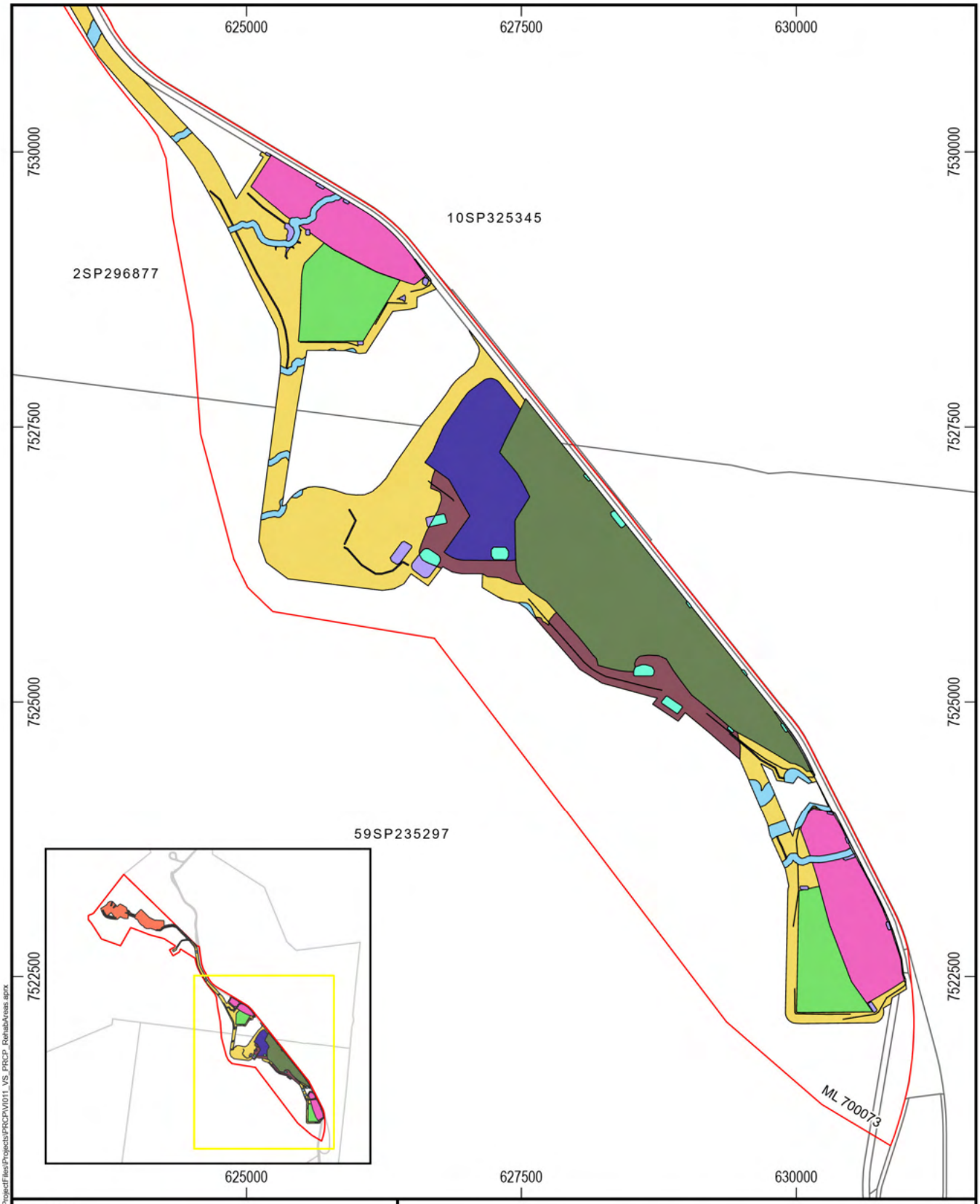
Datum: GDA2020
Projection: MGA55

FIGURE 10-2A

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

Path: \\mets-dc-02\Shared_Data\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\VI011_VS_PRCP_RehabAreas.aprx



Legend

- Cadastral Boundary
- MLA Area

Rehabilitation Areas

- RA1
- RA2
- RA3
- RA4
- RA5
- RA6
- RA7
- RA8
- RA9
- RA10

Source: State of Queensland (Department of Resources) 2022, Vitrinite 2020-2023, METServe 2020-2023.

Path: \\mets-dc-02\Shared_Data\Projects\VI011_VCP_Stage2\ArcGIS\ProjectFiles\Projects\PRCP\VI011_VS_PRCP_RehabAreas.aprx

Vulcan South
Rehabilitation Areas
Southern Section

0 0.5 1 2

Kilometers

Scale: 1:50,000 (A4)

21/11/2023

Datum: GDA2020
Projection: MGA55

FIGURE 10-2B

VITRINITE BRIGHTER COAL

METSERVE Mining & Energy Technical Services Pty Ltd

10.2 Schedule of Land Availability

Land will become available for rehabilitation progressively through the life of the Project. Disturbed land is available for rehabilitation when:

- the land is no longer being mined;
- the land is no longer being used to dump further waste rock;
- the land is no longer being used for operating infrastructure or machinery for mining;
- the land is no longer being used for transport associated with operational or rehabilitation activities (in the case of haul roads particularly those associated with highwall mining); and
- the land does not support permanent infrastructure (e.g., Saraji Road).

10.2.1 Timing Considerations

Mine plans, which include the schedule of land available for rehabilitation, have been developed for each 12 months starting at the commencement of the Project. However, in accordance with the *Progressive Rehabilitation and Closure Plans Guideline*, annual reporting of rehabilitation works is to be based on the completion date of 10 December each calendar year. Consequently, the progression of the mine (and its rehabilitation) within any one calendar year is strongly dependent on the date the Project commences. All calculations and predictions of land availability within each calendar year are based on the current forecast Project commencement date of 15th of June 2024. This date is subject to change, pending the government approval process.

One rehabilitation milestone (revegetation) is strongly season-dependent, and is only to take place following the start of wet season rain. It is assumed that any land available for rehabilitation later than July in any one calendar year is unlikely to have sufficient time to undergo infrastructure removal, decontamination and final landform shaping in preparation for revegetation at the start of the wet season (November-January, depending on the year). Consequently, deferring the commencement of rehabilitation of such land until the following year will not delay the revegetation stage.

Land that is available for rehabilitation before July will commence rehabilitation in the same calendar year. It is expected that rehabilitation milestones RM1, RM2 and RM3 (see **Section 10.3**) will be completed in the year that land becomes available for rehabilitation. Milestones RM4 and RM5 may also be completed the same year (relative to the reporting date of 10 December), but only if the wet season commences early (e.g., November). As the start of the wet season is unpredictable, for the purposes of the schedule, it is assumed that milestones RM4 and RM5 will be completed early in the following year, and hence are attributed to the following years' progress in the schedule. There is a ten year period scheduled between RM5 and RM6 – RM10 to allow trees to establish.

Based on tree growth rates and pasture development at other mines in central Queensland (Mulligan *et al.* 2006), it is expected that the target vegetation community will be established ten years after planting, and the land will be suitable for the commencement of grazing at this time. This is a conservative estimate to allow for opportunities for remedial planting in the event of initial failures; grazing has been successfully introduced to central Queensland pastures with trees that are as young as four years old (Donaghy *et al.* 2010).

10.2.2 Schedule of Availability

The schedule of land availability for rehabilitation in each rehabilitation area is shown in **Table 10-1**.

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Table 10-1 Schedule of land availability for rehabilitation

Rehabilitation Area		Land available for rehabilitation in each year (ha)*												
		2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	Total by RA
RA1	North and South Ex-pit Dumps	0	0	56.0	0	0	0	44.6	0	0	0	0	0	100.6
RA2	Main Ex-pit Dump	0	0	0	91.1	0	0	0	0	0	0	0	0	91.1
RA3	Reinstated Watercourse	0	0	0	0	0	0	0	0	0	0	23.1	23.0	46.1
RA4	North and South In-pit Dumps	0	32.7	29.4	0	0	0	30.3	43.0	0	0	0	0	135.4
RA5	Main In-pit Dump	0	0	39.9	0	94.9	43.8	41.8	44.3	0	0	0	0	264.7
RA6	Previously wooded infrastructure areas (infrastructure, haul roads, offices, stockpiles, train load-out, rail loop CHPP, MIA and magazine)	0	0	0	0	0	0	0	0	99.7	99.7	99.7	99.6	398.7
RA7	Previously cleared infrastructure areas (haul roads)	0	0	0	0	0	0	0	0	0	0	0	68.0	68.0
RA8	Water management infrastructure in previously wooded areas	0	0	0	0	0	0	0	0	14.1	0	0	0	14.1
RA9	Water management infrastructure in previously cleared areas	0	0	0	0	0	0	0	0	10.1	0	0	0	10.1
RA10	Highwall Mining Area	0	266.1 (48.0)#	0	0	0	0	0	0	0	0	0	0	266.1
	Total by year	**0**	**298.8**	**125.3**	**91.1**	**94.9**	**43.8**	**116.7**	**87.3**	**123.9**	**99.7**	**122.75**	**190.65**	**1394.9**

*Land areas represent hectares of land that becomes available for the first time in that year (i.e., is not cumulative across years).

†Erosion control infrastructure is to remain in place until sufficient vegetative cover has developed on rehabilitated land. This is conservatively estimated to be three years post-mining, but may be sooner.

‡The realigned Saraji Road corridor will be constructed and operational within year 1, however further rehabilitation works within the corridor fringes may be required following construction of the final in-pit dump landform. Hence rehabilitation works are schedule to occur after the landform is established. The RA5 area calculation is conservative as it assumes a potential realignment of the entirety of Saraji road intercepting the MLA rather than the likely realignment around the northern, central and southern open pits to allow for their slight extension outside of the MLA, in consultation with IRC. The exact area requiring rehabilitation was revisited following conditions when mining of the pits commence.

The disturbance footprint is extremely conservative whereby it is very unlikely that the panel disturbance will result in any surface disturbance and will be implemented with the design objective of not subsiding land above the plunges. However, the disturbance of the highwall mining bench, highwall rock dump and associated roads (48 ha) has been included for context.

10.3 Rehabilitation Milestones

Rehabilitation milestones relevant to the Project area are listed in **Table 10-2**.

Table 10-2 Rehabilitation milestones

Code	Milestone	Description	Applicable Rehabilitation Areas
RM1	Infrastructure decommissioning and removal.	▪ Geotechnical assessments for drifts, shafts, tunnels and other openings have been undertaken; ▪ Disconnect and terminate services such as water and electricity; ▪ Pipelines and drainage infrastructure drained and removed; ▪ Demolish and remove buildings and infrastructure(modular CHPP, TLO, administration, ablution block, workshops, magazine and warehouses, etc.); ▪ Bitumen, blue metal, aggregate, etc., have been removed; ▪ Fencing has been removed; ▪ Rail tracks and balast have been removed; and ▪ Boreholes have been decommissioned.	RA6, RA7, RA8, RA9 and RA10
RM2	Remediation of contaminated land.	▪ Contaminated land investigations have been carried out; ▪ Contaminated water (e.g. affected by hydrocarbons) has been treated on site or removed; ▪ Contaminated materials have been appropriately removed and disposed of; ▪ On-site remediation of hydrocarbon-contaminated soils has been completed; and ▪ Completion of validation testing to confirm that contaminated soils have been removed/remediated.	RA4, RA5, RA6, RA7, RA8, RA9 and RA10
RM3	Landform development and reshaping/re-profiling.	▪ Bulk earthworks to achieve required landform and slopes have been completed; ▪ Placement of subsoils over waste rock has been completed; ▪ General reshaping to achieve final landform is complete; and ▪ Installation of erosion and sediment control systems is complete. ▪ Post-closure drainage channels are complete ▪ The final landform surveying is complete ▪ Areas of surface ponding have been remediated	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA10
RM4	Surface preparation.	▪ Remediation any erosion or subsidence is complete; ▪ Growth media (topsoil) has been sourced, carted and spread; ▪ Ameliorants to improve or stabilise soils have been added; and ▪ Soil health and suitability has been assessed by an AQP ▪ All ponding, surface cracks and erosion classified as moderate or severe have been remediated. ▪ Topsoil has met suitability targets	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA10
RM5	Revegetation.	▪ Revegetation of the PMLU has been undertaken to resemble a pre-existing RE from within the disturbance footprint; ▪ Direct seeding has been completed; ▪ Fertiliser has been applied; ▪ Vegetation groundcover meets criteria ▪ Seeding has been completed at the appropriate rate for each PMLU and only contains those listed in **Table 6-6** or Attachment 2 of the approved Schedule ▪ Tube stock has been planted within one year for sites failing to achieve vegetation establishment; and	RA1, RA2, RA3, RA4, RA5, RA6, RA7, RA8, RA9 and RA10

		▪ Stock fencing to protect planting has been installed, where deemed appropriate	
RM6	Land is suitable for the commencement of grazing.	▪ Pasture is sufficiently productive to support grazing and (where relevant) trees are sufficiently tall to avoid damage by cattle; ▪ Internal stock fencing, to separate land ready for grazing from that not yet developed sufficiently, has been installed; and ▪ Water sources for cattle have been installed. ▪ All corrective actions to erosion recommended by the AQP have been implemented, ▪ Achievement of runoff surface water quality criteria (pH: 6.5-8.5; TSS <110 mg/L and EC: <310 µS/cm.)	RA2, RA5, RA7 and RA9
RM7	Establishment of target vegetation in non-riparian areas	▪ Monitoring has determined that vegetation meets the completion criteria. ▪ After vegetation establishment (after 6 to 12 months since sowing) soils will be re-tested to determine if any follow-up application of ameliorants is required. ▪ Achievement of runoff surface water quality criteria (pH: 6.5-8.5; TSS <110 mg/L and EC: <310 µS/cm.) ▪ The monitoring of BioCondition has been undertaken by an appropriately qualified person as per the latest version of the BioCondition Assessment Manual. ▪ Rehabilitation areas achieve a BioCondition score of at least 40/80, based on benchmarks relevant to the PMLU (**Table 9-3**) ▪ Soil testing indicates parameters are met, as per below: • Rootzone EC <1.5 dS/m (1,500 µS/cm); • Soil pH <8.5 and >5.5 (average) as measured at any part of the root zone; • Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).	RA1, RA4, RA5, RA6, RA8 and RA10
RM8	Establishment of target vegetation in riparian areas	▪ Rehabilitated areas have ≤0.2% cover of Parthenium hysterophorus AND rehabilitated areas are to have ≤0.1% cover of Harrisia martinii AND any other weeds listed under the Biosecurity Act are to be present in densities of <1 individual per hectare, as confirmed by an appropriately qualified person from annual monitoring; ▪ Rehabilitated areas contain Eucalyptus camaldulensis and at least one other species of Corymbia or Eucalyptus; ▪ Eucalyptus camaldulensis constitutes 33% of the total basal area of woody vegetation; ▪ The monitoring of BioCondition has been undertaken by an appropriately qualified person as per the latest version of the BioCondition Assessment Manual. ▪ Rehabilitation areas achieve a BioCondition score of at least 40/80, based on benchmarks relevant to the analogous regional ecosystem 11.3.25 (**Table 9-3**); and ▪ Soil testing indicates the following parameters are met: • Rootzone EC <1.5 dS/m (1,500 µS/cm), • Soil pH <8.5 and >6 as measured at any part of the root zone, • Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).	RA3
RM9	Achievement of native ecosystem land use with a stable condition	▪ Monitoring has determined that that the land is safe, structurally stable, does not cause environmental harm and is able to sustain the PMLU; ▪ The monitoring of BioCondition has been undertaken by an appropriately qualified person as per the latest version of the BioCondition Assessment Manual. ▪ All RE's across the project area have achieved a BioCondition score of at least 60/80 for achievement of native ecosystem land use with a stable condition, based on benchmarks relevant to the PMLU; ▪ Weed cover is below threshold;	RA1, RA3, RA4, RA6, RA8 and RA10

		▪ All downstream surface water quality parameters are to be in accordance with EA limits (**Table 9-7**) as derived from approved monitoring locations (Table 9-5). ▪ Sites have fulfilled all other milestone criteria after having experienced at least one "drought" year ▪ All corrective actions to erosion recommended by the AQP have been implemented, ▪ Final landform is free draining and is approved to be geotechnically stabl;e by an AQP ▪ Groundcover is above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower than 10%; ▪ Erosion monitoring is complete and results indicate accordance with requirements ▪ Soil testing indicates the following parameters are met: • Rootzone EC <1.5 dS/m (1,500 µS/cm), • Soil pH <8.5 and >6 as measured at any part of the root zone, • Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth). ▪ Natural recruitment meets threshold ▪ Soil testing indicates the following parameters are met: • Rootzone EC <1.5 dS/m (1,500 µS/cm), • Soil pH <8.5 and >6 as measured at any part of the root zone, ▪ • Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).	
RM10	Achievement of cattle grazing land use with a stable condition	▪ Monitoring has determined that that the land is safe, structurally stable, does not cause environmental harm and is able to sustain the PMLU.	RA2, RA5, RA7 and RA9

10.3.1 Milestone Criteria

Milestone criteria pertaining to each of the rehabilitation milestones are listed in **Table 10-3**.

Table 10-3 Milestone Criteria

Code	Milestone	Milestone criteria
RM1	Infrastructure decommissioning and removal.	▪ With the exception of any infrastructure to remain as part of the post-mining land use (PMLU) or where infrastructure is agreed to be retained by the landholder as evidenced by a signed landholder agreement, the following are complete: ▪ RM1.1 All services disconnected, terminated and removed; ▪ RM1.2 All hardstand, concrete areas and road materials (bitumen, gravel) removed; ▪ RM1.3 All pipelines (above- and below- ground) drained and removed; ▪ RM1.4 All fencing that is not part of the post mining land use (PMLU) removed; ▪ RM1.5 All buildings demolished and removed; ▪ RM1.6 All machinery and equipment removed; ▪ RM1.7 All surface water drainage infrastructure that is not required in the PMLU is removed; ▪ RM1.8 All rubbish removed; ▪ RM1.9 All waste is to be transported, disposed of, and handled in accordance with relevant waste legislature; and ▪ RM1.10 All drifts, shafts, tunnels, boreholes, and other openings to be sealed, and are geotechnically stable and certified by an appropriately qualified person (AQP).

Code	Milestone	Milestone criteria
RM2	Remediation of contaminated land.	▪ RM2.1 Detailed site investigation report, as required under the Environmental Protection Act 1994 (EPA 1994), completed; ▪ RM2.2 All contamination is remediated or removed from site; ▪ RM2.3 Any contamination removed from site has been removed in accordance with relevant regulations; and ▪ RM2.4 A contaminated land investigation document has been prepared by an approved auditor, containing a site suitability statement that states that land is not contaminated and is suitable to achieve the PMLU.
RM3	Landform development and reshaping/reprofiling.	▪ RM3.1 All earthworks except topsoil handling and placement are complete; ▪ RM3.2 Subsoil of a suitable quality, as signed-off by an AQP, has been applied, spread and compacted over RA2 (in-pit dumps) to the specified depth (minimum of 0.3 m) and design specifications; ▪ RM3.3 All erosion and sediment control systems have been installed as per the construction design and are functioning properly as verified by an AQP; ▪ RM3.4 The final landform surveyed is to be constructed as per the approved design plan; ▪ RM3.5 Batters do not exceed a maximum slope of 15% and are stable as demonstrated by erosion modelling; ▪ RM3.6 All areas of substantial surface cracking (vertosol soil types) or subsidence are remediated and no associated effects of erosion or changed surface water flow paths are evident; ▪ RM3.7 Areas of surface ponding are remediated by re-profiling and ripping to be free draining; ▪ RM3.8 All rehabilitation and associated works are to have 'as-constructed' plans prepared; ▪ RM3.9 All pits are backfilled and are certified as geotechnically stable by an AQP; ▪ RM3.10 Post-closure drainage channels are reinstated with similar geometry and vegetation characteristics to pre-mining drainage channels. This includes: ▪ a) Pre-mining channel longitudinal slope and geometry to be reinstated; and ▪ b) Channel and floodplain to function as a natural drainage line including similar geomorphic and vegetation characteristics to pre-mining conditions; ▪ RM3.11 Permanent drainage channels to be designed in accordance with the Guideline: Works that interfere with water in a watercourse for a resource activity— watercourse diversions authorised under the Water Act 2000; and ▪ RM3.12 All drainage channels and associated works are to have 'as-constructed' plans prepared.

Code	Milestone	Milestone criteria
RM4	Surface preparation.	▪ RM4.1 Any erosion classified as 'moderate' or 'severe' as defined in Attachment 1 - Erosion classification framework, that occurs after the achievement of RM3, has been remediated prior to topsoil application; ▪ RM4.2 All substantial surface cracks or subsidence evident after the achievement of RM3, have been remediated prior to topsoil application; ▪ RM4.3 Areas of ponding that persist after the achievement of RM3 have been remediated and are free draining prior to topsoil application; ▪ RM4.4 Soil health and suitability is assessed and documented by an AQP to confirm topsoil is suitable for the PMLU and target vegetation establishment; ▪ RM4.5 Prior to topsoil application, an assessment of the need for soil amelioration has been undertaken and soil ameliorants such as fertiliser, gypsum and/or organic matter have been applied at rates determined by an AQP; ▪ RM4.6 A minimum of 0.25 m of topsoil suitable for the PMLU has been placed over all areas (except for RA10). ▪ RM4.7 Topsoil (equivalent to a depth of 0.15 m) has been mixed with crushed rock to achieve a final depth of 0.25m and applied to RA10 as per final design specifications; ▪ RM4.8 Organic mulch is applied at a rate of at least 5t/ha of hay or organic material on all slopes; ▪ RM4.9 Topsoil to meet the following suitability targets: a) pH in the range of 5.5 - 8.5 (average); b) Electrical Conductivity (EC) ≤1.5 dS/m (1,500 µS/cm); and c) Exchangeable sodium percentage (ESP) <6%.
RM5	Revegetation.	▪ RM5.1 Seeding is completed at an average rate of: a) Grazing PMLU - 0.25 kg/ha for trees and shrubs, 13-15 kg/ha for grasses and 13-15 kg/ha for sterile cover crops; ▪ b) Native ecosystem PMLU - 2-3 kg/ha for trees and shrubs, 9-11 kg/ha for grasses and 8-10 kg/ha for sterile cover crops; and ▪ c) Native ecosystem – riparian PMLU – 2-3 kg/ha for trees and shrubs, 13-15 kg/ha for grasses and 13-15 kg/ha for sterile cover crops; ▪ RM5.2 With the exception of a non-permanent cover crop species, the seed mix to satisfy RM5.1 contains only those species listed in Attachment 2 – Seed Mix Species List for the relevant PMLU and reflect the regional ecosystem distribution spatially shown in Figure 4 - Spatial extent of regional ecosystems to be established post-mining; ▪ RM5.3 Vegetation groundcover >40%; ▪ RM5.4 Any species not establishing after seeding (as identified 12 months after seeding) have been planted as tubestock in RA2, RA3 and RA4 at a density suitable to establish the tree cover and shrub cover of the relevant PMLU; and ▪ RM5.5 Supplementary seeding and tubestock planting completed within one year of sites failing to achieve vegetation establishment on initial attempt.

Code	Milestone	Milestone criteria
RM6	Land is suitable for the commencement of grazing.	▪ RM6.1 Perennial pasture cover >50%; ▪ RM6.2 Rehabilitated areas are to have less than 0.2% cover of Parthenium hysterophorus AND rehabilitated areas are to have less than 0.1% cover of Harrisia martinii AND any invasive plants listed under the Biosecurity Act 2014 are not to exceed densities of 1 individual per hectare, as confirmed by an AQP from annual monitoring; ▪ RM6.3 All corrective actions recommended by an AQP in response to erosion or deficiencies in vegetation cover criteria have been implemented; ▪ RM6.4 Rehabilitated areas are to have a land suitability class for cattle grazing of 3 or lower; ▪ RM6.5 No active rill or gully erosion deeper than 30 cm present as stated in Attachment 1 – Erosion classification framework; ▪ RM6.6 Trees of the target species, as identified in Attachment 2 – Seed Mix Species List are, on average, at least 4 m tall; ▪ RM6.7 Stock water sources have been installed and meet the approved water criteria for stock use (EC <7800 µS/cm); ▪ RM6.8 Stock fencing installation is complete; and ▪ RM6.9 Rehabilitation is non-polluting of surface water and achieves surface water runoff water quality criteria of: a) pH: 6.5-8.5; b) TSS <110 mg/L; and c) EC: <310 µS/cm.
RM7	Establishment of target vegetation in non-riparian areas	▪ RM7.1 Rehabilitated areas are to have less than 0.2% cover of Parthenium hysterophorus AND rehabilitated areas are to have less than 0.1% cover of Harrisia martinii AND any invasive plants listed under the Biosecurity Act 2014 are not to exceed densities of 1 individual per hectare, as confirmed by an AQP from annual monitoring; ▪ RM7.2 Vegetation groundcover >50%; ▪ RM7.3 A BioCondition assessment is undertaken by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's 'BioCondition Assessment Manual'; ▪ RM7.4 A rehabilitation performance assessment completed under RM7.3 achieves a score of at least 40/80 of the reference site based on the benchmark criteria in **Table 9-3** for the relevant native ecosystem PMLU; ▪ RM7.5 Rehabilitation is non-polluting of surface water and achieves water quality criteria of: a) pH: 6.5-8.5; b) TSS 110 mg/L; and c) EC: <310 µS/cm; ▪ RM7.6 Soil testing indicates the following parameters are met: a) Rootzone EC <1.5 dS/m (1,500 µS/cm); b) Soil pH <8.5 and >5.5 (average) as measured at any part of the root zone; c) Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).

Code	Milestone	Milestone criteria
RM8	Establishment of target vegetation in riparian areas	▪ RM8.1 Rehabilitated areas are to have less than 0.2% cover of Parthenium hysterophorus AND rehabilitated areas are to have less than 0.1% cover of Harrisia martinii AND any invasive plants listed under the *Biosecurity Act 2014* are to be <1 individual per hectare, as confirmed by an AQP from annual monitoring; ▪ RM8.2 Vegetation groundcover > 50%; ▪ RM8.3 Eucalyptus camaldulensis is to constitute 33% of the total basal area of woody vegetation; ▪ RM8.4 A BioCondition assessment is undertaken by an AQP using the methodology outlined in the latest version of the Queensland's Herbarium 'BioCondition Assessment Manual'; ▪ RM8.5 A rehabilitation performance assessment completed under RM8.4 must achieve a score of 40/80 of the reference site based on the benchmark criteria in Table 9-3 for the native ecosystem - riparian PMLU (RE11.3.25); ▪ RM8.6 Rehabilitation is non-polluting of surface water and achieves water quality criteria of: a) pH: 6.5-8.5; b) TSS 110 mg/L; and c) EC: <310 µS/cm; ▪ RM8.7 Soil testing indicates the following parameters are met: a) Rootzone EC <1.5 dS/m (1,500 µS/cm); b) Soil pH <8.5 and >5.5 (average) as measured at any part of the root zone; c) Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).
RM9	Achievement of native ecosystem land use with a stable condition.	▪ RM9.1 All corrective actions recommended by an AQP in response to erosion or deficient vegetation cover have been implemented; ▪ RM9.2 No evidence of erosion classified as 'moderate' or 'severe' as defined by Attachment 1 – Erosion classification framework; ▪ RM9.3 An AQP has certified that the final landform is geotechnically stable; ▪ RM9.4 Native ecosystems are to be substantially established spatially as per Figure 1-16- Spatial extent of regional ecosystems to be established post-mining for the relevant PMLU; ▪ RM9.5 A BioCondition assessment has been undertaken by an AQP using the methodology outlined in the latest version of the Queensland Herbarium's 'BioCondition Assessment Manual'; ▪ RM9.6 A rehabilitation performance assessment completed under RM9.5 achieves a score of 60/80 based on the benchmark criteria in Table 9-3 for the relevant PMLU; ▪ RM9.7 Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 50% on slopes with a gradient lower than 10%; ▪ RM9.8 Erosion monitoring has been completed and the average erosion rate is <5 t/ha/year; ▪ RM9.9 No active rill or gully erosion deeper than 30cm present; ▪ RM9.10 Rehabilitated areas have less than 0.2% cover of Parthenium hysterophorus AND rehabilitated areas less than 0.1% cover of Harrisia martinii AND any invasive plants listed under the Biosecurity Act 2014 are not to exceed 1 individual per hectare, as confirmed by an AQP from annual monitoring; ▪ RM9.11 At least 60% of established target species show natural recruitment; ▪ RM9.12 Free draining landform and no cracks greater than 0.15 m deep; ▪ RM9.13 The extent and frequency of surface cracking and ponding of the mined land is within 10% of that measured in adjacent unmined land; ▪ RM9.14 Surface water quality results monitored monthly during flow at, but not limited to, downstream locations specified in Attachment 4 - Surface Water Monitoring Locations, must not exceed the parameters and limits defined in Attachment 5 - Surface Water Quality Limits for a minimum of 5 consecutive years; ▪ RM9.15 Soil testing indicates the following parameters are met: ▪ a) Rootzone EC <1.5 dS/m (1,500 µS/cm); ▪ b) Soil pH <8.5 and >5.5 (average) as measured at any part of the root zone; ▪ c) Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).

Code	Milestone	Milestone criteria
RM10	Achievement of cattle grazing ;land use with a stable condition	▪ RM10.1 All corrective actions recommended by an AQP in response to erosion or deficient vegetation cover have been implemented; ▪ RM10.2 No evidence of erosion classified as 'moderate' or 'severe' as defined by Attachment 1 – Erosion classification framework; ▪ RM10.3 An AQP has certified that the final landform is geotechnically stable; ▪ RM10.4 The land suitability class of rehabilitated land is to be 3 or lower for cattle grazing; ▪ RM10.5 >6 species of perennial pasture species present and perennial grass cover >30%; ▪ RM10.6 Groundcover is to remain above 80% on all slopes with a gradient higher than 10%, and 70% on slopes with a gradient lower than 10%; ▪ RM10.7 Erosion monitoring has been completed and the average erosion rate is <5 t/ha/year; ▪ RM10.8 No active rill or gully erosion deeper than 30 cm present; ▪ RM10.9 Rehabilitated areas have less than 0.2% cover of Parthenium hysterophorus AND rehabilitated areas are to have less than 0.1% cover of Harrisia martinii AND any invasive plants listed under the *Biosecurity Act 2014* do not exceed 1 individual per hectare, as confirmed by an AQP from annual monitoring; ▪ RM10.10 Surface water quality results monitored monthly during flow at, but not limited to, downstream locations specified in Attachment 4 - Surface Water Monitoring Locations, must not exceed the parameters and limits defined in Attachment 5 - Surface Water Quality Limits for a minimum of 5 consecutive years; ▪ RM10.11 Soil testing indicates the following parameters are met: a) Rootzone EC <1.5 dS/m (1,500 µS/cm); b) Soil pH <8.5 and >5.5 (average) as measured at any part of the root zone; c) Exchangeable Sodium Percentage (ESP%) <6% (at 0-10cm depth).

*These milestone criteria preclude areas undisturbed by mining and still within the disturbance footprint.
^For Erosion Monitoring Classifications, see Section 9.6.1 of the **Vulcan South Soils and Land Suitability Assessment** (**Appendix C**).

10.4 PRC Plan Schedule

The PRC Plan Schedule is provided in **Table 10-4.**

Table 10-4 PRC Plan Schedule

Rehabilitation area	RA1											
Relevant activities	North and South Ex-Pit Waste Rock Dump											
Total size of rehabilitation area (ha)	100.6 ha											
Commencement of first milestone (RM1)	1-Aug-26											
PMLU	Native ecosystems non-riparian (RE11.4.8, 11.5.3 and 11.10.3)											
Date area is available	31/07/26	10/12/27	31/07/30	10/12/31	10/12/32	10/12/38						
Cumulative area available (ha)	56	56	100.6	100.6	100.6	100.6						
	Milestone completed by											
	10/12/27	10/12/28	10/12/31	10/12/32	10/12/38	10/12/42						
Milestone code	**Cumulative area achieved (ha)**											
RM3	56	56	100.6									
RM4		56	56	100.6								
RM5		56	56	100.6	100.6							
RM7					56	100.6						
RM9					56	100.6						

Rehabilitation area	RA2													
Relevant activities	Main Ex-pit Waste Rock Dump													
Total size of rehabilitation area (ha)	91.1 ha													
Commencement of first milestone (RM1)	1-Aug-27													
PMLU	Low-intensity cattle grazing													
Date area is available	31/07/27	10/12/28	10/12/29											
Cumulative area available (ha)	91.1	91.1	91.1											
	Milestone completed by													
	10/12/28	10/12/29	10/12/39											
Milestone code	Cumulative area achieved (ha)													
RM3	91.1													
RM4		91.1												
RM5		91.1												
RM6			91.1											
RM10			91.1											

Rehabilitation area		RA3											
Relevant activities		Reinstated Watercourses											
Total size of rehabilitation area (ha)		46.1											
Commencement of first milestone (RM1)		1-Aug-34											
PMLU		Native ecosystems riparian (RE11.3.25)											
Date area is available	31/07/34	31/07/35	10/12/36	10/12/37	10/12/46								
Cumulative area available (ha)	23.1	46.1	46.1	46.1	46.1								
	Milestone completed by												
	10/12/35	10/12/36	10/12/37	10/12/46	10/12/47								
Milestone code	Cumulative area achieved (ha)												
RM3	23.1	46.1											
RM4		23.1	46.1										
RM5		23.1	46.1	46.1									
RM8				23.1	46.1								
RM9				23.1	46.1								

Rehabilitation area	RA4										
Relevant activities	North and South In-pit dumps										
Total size of rehabilitation area (ha)	135.4 ha										
Commencement of first milestone (RM1)	1-Aug-25										
PMLU	Native ecosystems non-riparian										
Date area is available	31/07/25	31/07/26	31/07/30	31/07/31	10/12/32	10/12/33	10/12/37	10/12/41	10/12/42		
Cumulative area available (ha)	32.7	62.1	92.4	135.4	135.4	135.4	135.4	135.4	135.4		
	Milestone completed by										
	10/12/26	10/12/27	10/12/31	10/12/32	10/12/33	10/12/37	10/12/41	10/12/42	10/12/43		
Milestone code	Cumulative area achieved (ha)										
RM2	32.7	62.1	92.4	135.4							
RM3	32.7	62.1	92.4	135.4							
RM4		32.7	62.1	92.4	135.4						
RM5		32.7	62.1	92.4	135.4	135.4	135.4	135.4			
RM7						32.7	62.1	92.4	135.4		
RM9						32.7	62.1	92.4	135.4		

Rehabilitation area		RA5												
Relevant activities		Main In-pit Waste Rock Dump												
Total size of rehabilitation area (ha)		264.7 ha												
Commencement of first milestone (RM1)		1-Aug-26												
PMLU		Low-intensity cattle grazing												
Date area is available	31/07/26	31/07/28	31/07/29	31/07/30	31/07/31	10/12/32	10/12/33	10/12/39	10/12/40	10/12/41	10/12/42			
Cumulative area available (ha)	39.9	134.8	178.6	220.4	264.7	264.7	264.7	264.7	264.7	264.7	264.7			
	Milestone completed by													
	10/12/27	10/12/29	10/12/30	10/12/31	10/12/32	10/12/33	10/12/39	10/12/40	10/12/41	10/12/42	10/12/43			
Milestone code	Cumulative area achieved (ha)													
RM2	39.9	134.8	178.6	220.4	264.7									
RM3	39.9	134.8	178.6	220.4	264.7									
RM4		39.9	134.8	178.6	220.4	264.7								
RM5		39.9	134.8	178.6	220.4	264.7	264.7	264.7	264.7	264.7				
RM6							39.9	134.8	178.6	220.4	264.7			
RM10							39.9	134.8	178.6	220.4	264.7			

Rehabilitation area	RA6													
Relevant activities	Previously wooded infrastructure areas (infrastructure, haul roads, offices, stockpiles, train load-out, rail loop CHPP, MIA and magazine)													
Total size of rehabilitation area (ha)	398.7 ha													
Commencement of first milestone (RM1)	1-Aug-32													
PMLU	Native ecosystems non-riparian (RE11.9.2, 11.5.9, 11.5.3, 11.10.1, 11.10.3, and 11.4.8)													
Date area is available	31/07/32	31/07/33	31/07/34	31/07/35	10/12/36	10/12/37	10/12/44	10/12/45	10/12/46					
Cumulative area available (ha)	99.7	199.4	299.1	398.7	398.7	398.7	398.7	398.7	398.7					
	Milestone completed by													
	10/12/33	10/12/34	10/12/35	10/12/36	10/12/37	10/12/44	10/12/45	10/12/46	10/12/47					
Milestone code	**Cumulative area achieved (ha)**													
RM1	99.7	199.4	299.1	398.7										
RM2	99.7	199.4	299.1	398.7										
RM3	99.7	199.4	299.1	398.7										
RM4		99.7	199.4	299.1	398.7									
RM5		99.7	199.4	299.1	398.7									
RM7						99.7	199.4	299.1	398.7					
RM9						99.7	199.4	299.1	398.7					

Rehabilitation area				RA7									
Relevant activities				Previously cleared infrastructure areas (haul roads)									
Total size of rehabilitation area (ha)				68.0 ha									
Commencement of first milestone (RM1)				1-Aug-35									
PMLU				Low-intensity cattle grazing									
Date area is available	31/07/35	10/12/36	10/12/37										
Cumulative area available (ha)	68	68	68										
	Milestone completed by												
	10/12/36	10/12/37	10/12/47										
Milestone code	**Cumulative area achieved (ha)**												
RM1	68												
RM2	68												
RM3	68												
RM4		68											
RM5		68											
RM6			68										
RM10			68										

Rehabilitation area		RA8												
Relevant activities		Water management infrastructure in previously wooded areas												
Total size of rehabilitation area (ha)		14.1 ha												
Commencement of first milestone (RM1)		1-Aug-32												
PMLU		Native ecosystems non-riparian (RE11.9.2, 11.5.9, 11.5.3, 11.10.1, 11.10.3,11.4.8)												
Date area is available	31/07/32	10/12/33	10/12/34											
Cumulative area available (ha)	14.1	14.1	14.1											
	Milestone completed by													
	10/12/33	10/12/34	10/12/44											
Milestone code	**Cumulative area achieved (ha)**													
RM1	14.1													
RM2	14.1													
RM3	14.1													
RM4		14.1												
RM5		14.1												
RM7			14.1											
RM9			14.1											

Rehabilitation area		RA9												
Relevant activities		Water management infrastructure in previously cleared areas												
Total size of rehabilitation area (ha)		10.1 ha												
Commencement of first milestone (RM1)		1-Aug-32												
PMLU		Low-intensity cattle grazing												
Date area is available	31/07/32	10/12/32	10/12/33											
Cumulative area available (ha)	10.1	10.1	10.1											
	Milestone completed by													
	10/12/32	10/12/33	10/12/43											
Milestone code	**Cumulative area achieved (ha)**													
RM1	10.1													
RM2	10.1													
RM3	10.1													
RM4		10.1												
RM5		10.1												
RM6			10.1											
RM10			10.1											

Rehabilitation area	RA10													
Relevant activities	Highwall Mining Area (bench, dams, ex-pit WRD)													
Total size of rehabilitation area (ha)	266.1 ha													
Commencement of first milestone (RM1)	1-Aug-25													
PMLU	Native ecosystems non-riparian (RE11.10.1 and 11.10.3)													
Date area is available	31/07/25	10/12/26	10/12/27											
Cumulative area available (ha)	266.1 (48.0)*	266.1 (48.0)*	266.1 (48.0)*											
	Milestone completed by													
	10/12/26	10/12/27	10/12/37											
Milestone code	**Cumulative area achieved (ha)**													
RM1	266.1													
RM2	266.1													
RM3	266.1													
RM4		266.1												
RM5		266.1												
RM7			266.1											
RM9			266.1											

11 REVISION OF THE PRC PLAN

The holder of a PRC Plan may, at any time, apply to the administering authority to amend their PRC Plan schedule (an amendment application). An application may be made to amend only the PRC Plan schedule, or as part of an amendment application for an EA. An amendment application must be submitted in the approved form and be accompanied by the relevant fee and an amended rehabilitation planning part for the holder's PRC Plan that complies with section 126C of the EP Act. Due to the dependencies between an EA and the PRC Plan schedule, an applicant should always consider whether a proposed amendment to the PRCP schedule requires a concurrent amendment to the EA in order to ensure consistency between both instruments.

Once a PRC Plan schedule has been amended, the rehabilitation planning part of the PRC Plan must be reviewed and revised to make any necessary or appropriate changes. The administering authority is to be provided with a copy of the amended PRC Plan within 10 business days of receiving a copy of the amended PRC Plan schedule (or receiving written notice under section 211 of the EP Act), unless the administering authority agrees to a longer period.

12 SPATIAL INFORMATION

Shapefiles detailing the following spatial information will be submitted in conjunction with this PRC Plan:

- the location and maximum extent of the disturbance footprint for the mine life;
- the PMLU for the area within the resource tenures; and
- the rehabilitation areas within the resource tenures.

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Appendix A – Surface Water Impact Assessment Report

Appendix B – Groundwater Impact Assessment Report

Appendix C – Soil and Land Suitability Assessment

Appendix D – Terrestrial Ecology Assessment Report

Appendix E – Stakeholder Engagement Plan

Appendix F – Landform Evolution Modelling

Appendix G –Geotechnical Assessment Memorandum

Appendix H – Geochemical Assessment

Appendix I – Offsets Strategy

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